

## RESEARCH ARTICLE

## Knowledge, attitudes, and practices of poultry vendors toward food safety in traditional markets in Mymensingh, Bangladesh: Implications for One Health and public health interventions



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### ABSTRACT

**Background and Aim:** Food safety in traditional poultry markets remains a major public health concern in low- and middle-income countries, where inadequate hygiene, poor regulatory oversight, and limited vendor training contribute to the transmission of foodborne pathogens and zoonotic diseases. Poultry vendors represent a critical control point in the farm-to-plate continuum, and their knowledge, attitudes, and practices (KAP) directly influence the safety of poultry products. In Bangladesh, traditional wet markets supply the majority of poultry meat, yet information on vendor-level food safety behavior, particularly from a One Health perspective, remains limited. This study aimed to evaluate the KAP of poultry vendors regarding food safety in traditional markets of Mymensingh district, Bangladesh, and to identify sociodemographic factors associated with inadequate food safety compliance.

**Materials and Methods:** A cross-sectional survey using questionnaires was carried out with 410 poultry vendors from five upazilas in Mymensingh district between July 2020 and June 2021. Vendors were chosen through stratified random sampling to represent various market types and vendor sizes. A structured, validated questionnaire evaluated sociodemographic data and KAP related to food hygiene, zoonotic disease transmission, antimicrobial resistance, personal protective measures, and waste management. The instrument's reliability and validity were confirmed through expert review, Cronbach's alpha, and test-retest analysis. Data analysis was conducted using R software, employing descriptive statistics, chi-square tests, and multivariable logistic regression to explore links between vendor traits and KAP outcomes. Statistical significance was defined as  $p < 0.05$ .

**Results:** Only 40.73% of vendors demonstrated adequate knowledge of food safety, while 42.68% showed a favorable attitude, and only 28.78% reported proper hygienic practices. None of the vendors had received formal training related to food safety or zoonoses. Although most vendors were aware of general hygiene measures, such as cleaning equipment and maintaining shop sanitation, significant gaps were observed in knowledge of antimicrobial resistance, zoonotic disease transmission, and cross-contamination risks. Use of personal protective equipment was very low, and many markets lacked proper drainage and waste disposal systems. Education level was strongly linked to knowledge and practice scores ( $p < 0.05$ ), while age and work experience were mainly associated with practices. Vendors selling multiple poultry types and those working in poorly regulated markets had higher odds of poor hygiene practices.

**Conclusion:** The study found significant gaps in food safety knowledge and hygiene practices among poultry vendors in traditional Bangladeshi markets, creating serious risks to human, animal, and environmental health. Improving food safety requires mandatory vendor training, regular inspections, better market infrastructure, and integration of One Health-based policies involving veterinary, public health, and environmental authorities. Focused educational initiatives and stricter regulations are crucial to boost vendor compliance, reduce foodborne illnesses, and promote safer poultry production and marketing systems in Bangladesh.

**Keywords:** antimicrobial resistance, Bangladesh, food safety, knowledge-attitude-practice, One Health, poultry vendors, traditional markets, zoonotic diseases.

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## INTRODUCTION

Food safety procedures are crucial for protecting public health, promoting sustainable development, and supporting economic growth [1, 2]. These measures are vital for controlling the spread of foodborne illnesses caused by harmful microorganisms, which are often associated with unsafe food handling and vending practices [3, 4]. During chicken processing and sales, poultry vendors play an important role in ensuring food safety by directly helping prevent foodborne diseases, especially in densely populated areas with limited hygiene facilities [5]. Gaps in vendors' knowledge or practices can greatly increase public health risks, emphasizing the need for targeted educational programs [6, 7].

The “farm-to-plate” continuum emphasizes the vital role of vendors in preventing contamination at various stages of food production, processing, and distribution [8]. Unsafe food leads to malnutrition, especially among vulnerable groups such as children, the elderly, and people with pre-existing health conditions [4]. Climate change and temperature swings further heighten food safety risks, adding to the burden on food vendors to uphold hygienic practices during food preparation and handling [9].

In Bangladesh, high population density, poor sanitation, and limited access to clean water make food safety a major public health issue [10, 11]. It is estimated that around 30 million people in Bangladesh suffer from foodborne illnesses each year, many of which are linked to unsafe practices in local poultry markets [12]. Vendors in these markets often lack proper facilities and training, leading to cross-contamination and the spread of pathogens during poultry dressing and processing [5]. Handling and preparing poultry is considered a high-risk activity because poultry may carry pathogens such as *Salmonella*, *Campylobacter*, and shiga-toxin-producing *Escherichia coli* [13, 14].

This study adopts a One Health perspective, placing poultry vendor practices at the intersection of human, animal, and environmental health. Poor food handling by vendors poses direct risks to human health because consumers may be exposed to foodborne pathogens such as *Salmonella*, *Campylobacter*, and pathogenic *E. coli* [5]. Poultry acts as a reservoir of zoonotic bacteria, linking animal health to public health outcomes [7]. Environmental health is also involved, as improper waste disposal, lack of drainage, and contamination of dressing water can promote microbial proliferation and attract pests, creating a persistent source of contamination [1, 10]. Integrating these dimensions aligns with the One Health strategies recommended by FAO, WHO, and WOA for food safety and antimicrobial resistance, emphasizing coordinated interventions across human, animal, and environmental sectors to reduce pathogen transmission and promote safe poultry production and marketing.

In wet markets, pathogens may spread through contaminated surfaces, tools, or hands, and unhygienic practices combined with the absence of personal protective equipment (PPE) increase the risk of contamination [15, 16]. In Bangladesh, local poultry markets are often poorly regulated and unhygienic, with wet floors that promote bacterial growth and biofilm formation [17]. These markets supply approximately 90%–95% of poultry meat and represent major hotspots for foodborne pathogen transmission [18, 19].

Numerous studies have assessed food handlers' knowledge, attitudes, and practices (KAP) related to food safety and hygiene [20–22]. However, previous research has shown that training alone does not always lead to significant improvements in behavior or hygiene practices among food handlers [23, 24]. In Bangladesh, poor KAP among food handlers remains an ongoing issue [23]. Traditional markets often process poultry in unhygienic conditions, increasing the risk of cross-contamination and foodborne illnesses [25, 26].

As the final link in the supply chain, vendors' poor practices, such as improper carcass disposal, lack of PPE, and use of contaminated tools, significantly increase food safety risks [5]. The strong dependence on local poultry markets in Bangladesh further elevates public health and economic risks, highlighting the need for continuous education, structured training programs, and regulatory monitoring of vendors [5, 27]. The WHO “Five Keys to Safer Food” provide practical guidance for vendors on cleanliness, safe handling, proper cooking, safe storage, and the use of clean water, which are essential for preventing foodborne diseases [28].

Despite increasing concern about food safety in developing countries, limited studies have specifically evaluated the KAP of poultry vendors in traditional wet markets, particularly from a One Health perspective integrating human, animal, and environmental health. Most previous studies conducted in Bangladesh and other low- and middle-income countries have focused mainly on consumers, slaughterhouse workers, or general food handlers, while poultry vendors operating in informal and semi-regulated markets remain understudied. Moreover, earlier investigations often relied on small sample sizes, convenience sampling, or non-validated questionnaires, which may limit the reliability and generalizability of their findings. In addition, few studies have examined the relationship between sociodemographic characteristics, vendor experience, and market conditions

with food safety behavior using robust statistical approaches such as multivariable analysis. Importantly, there is scarce information regarding poultry vendors in Mymensingh district, one of the major poultry production hubs in Bangladesh, where traditional markets supply a large proportion of poultry meat to the population. The absence of structured food safety training, limited regulatory monitoring, and poor market infrastructure in these settings may contribute to increased risks of foodborne diseases, zoonotic transmission, and antimicrobial resistance, yet these factors have not been comprehensively assessed. Therefore, a systematic and large-scale evaluation of poultry vendors' KAP is necessary to identify critical gaps and to support the development of effective One Health-based interventions for improving food safety in traditional poultry markets.

Based on the gaps identified above, this study was designed to thoroughly assess the KAP of poultry vendors regarding food safety in traditional markets of Mymensingh district, Bangladesh. It utilized a structured and validated questionnaire, stratified random sampling, and multivariable statistical analysis to gather reliable and representative data on vendor behavior and hygiene practices. Conducted within a One Health framework, the study aimed to evaluate how vendor practices might influence the transmission of foodborne pathogens at the human–animal–environment interface. We hypothesized that limited education, lack of formal training, and poor market infrastructure are significantly linked to unsafe food handling practices among poultry vendors. The specific objectives were (i) to measure the level of KAP related to food safety among poultry vendors, (ii) to identify sociodemographic and occupational factors associated with inadequate food safety compliance, and (iii) to provide evidence-based recommendations for improving vendor training, regulatory oversight, and hygiene management in traditional poultry markets. The results of this study are intended to assist policymakers, veterinary authorities, and public health agencies in developing targeted interventions to reduce foodborne disease risk and enhance food safety systems in Bangladesh under the One Health approach.

## **MATERIALS AND METHODS**

### **Ethical approval**

The study protocol was reviewed and approved by the Animal Welfare and Experimental Ethics Committee (AWEEC) of Bangladesh Agricultural University in Mymensingh, Bangladesh (Approval no. AWEEC/BAU/2020/12). The study was conducted following national research guidelines and international ethical standards for research involving human participants. Before data collection, the objectives, procedures, and potential benefits of the study were clearly explained to all participants in the local language. Written informed consent was obtained from each poultry vendor prior to participation. Participation was completely voluntary, and respondents were informed that they could withdraw from the study at any time without consequences.

No personal identifiers such as names, addresses, or contact details were recorded in the questionnaire. Each respondent was assigned a unique identification code to maintain anonymity. All collected data were kept confidential and stored in password-protected electronic files accessible only to the research team. The study did not involve any invasive procedures, biological sample collection, or experiments on humans or animals.

All procedures adhered to the ethical principles outlined in the Declaration of Helsinki and followed institutional and national research regulations. The study was conducted with respect for participants' privacy, dignity, and rights, and all information collected during the survey was used solely for academic and research purposes.

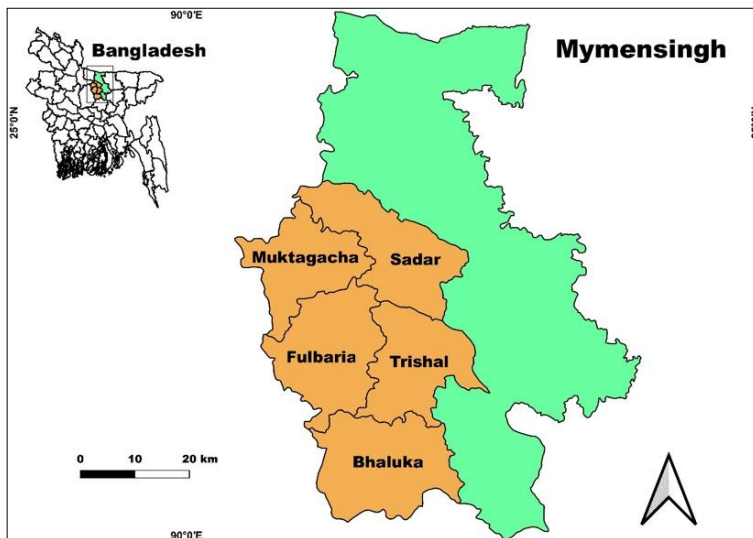
### **Study period and location**

Data collection took place from July 2020 to June 2021; however, no structured seasonal pattern was followed. Samples were collected randomly throughout the year. The five selected upazilas of Mymensingh district, Mymensingh Sadar, Fulbaria, Trishal, Bhaluka, and Muktagacha, were chosen based on their diverse representation of poultry vending practices, vendor demographics, and market conditions (Figure 1). Mymensingh is a key hub for livestock and poultry production in Bangladesh, contributing significantly to the country's GDP. These areas were selected to provide a broad view of traditional poultry vending within a high-production region. Each upazila has unique features in terms of market size, customer flow, vendor experience, and the types of poultry sold (e.g., broiler, Sonali, and native chickens). Additionally, these sites reflect a mix of urban and peri-urban environments, which helped ensure variability in sanitary infrastructure and vendor awareness levels.

### **Study design**

A structured, questionnaire-based face-to-face interview was conducted to assess the poultry vendors' KAP. A total of 82 broiler markets from five municipalities, each hosting at least five vendors and representing diverse

geographic and density profiles, were included to capture variability in vendor practices across the district. A comprehensive list of these markets, serving as the sampling frame, was compiled into a Microsoft Excel 2016 spreadsheet.



**Figure 1:** Map of the study area (Mymensingh Sadar, Muktagacha, Fulbaria, Trishal, and Bhaluka upazilas). The map was generated using QGIS version 3.14.16 (QGIS Development Team, Open Source Geospatial Foundation, USA).

A stratified random sampling method was employed to ensure representation across vendor sizes (small, medium, and large) and market types (formal/informal). Markets were divided by municipality and vendor density, and within each market, vendors were randomly chosen using Excel-generated randomization. To reduce selection bias, interviewers used a systematic approach, such as approaching every third vendor stall, and avoided targeting familiar or easily accessible individuals.

The interviews took place during regular market hours without prior notice to prevent response preparation or reporting bias. All interviewers received formal training to ensure consistency and repeatability in administering the questionnaire, which was pilot-tested with a small group of vendors before the main survey. Based on feedback from the pilot, the final version was refined for clarity and reliability. Interviewers read each question aloud in the local language, confirmed respondents understood them, and recorded answers directly, allowing enough time for each response. Respondents were informed about the study's purpose and assured that their responses would remain confidential.

### Determination of sample size

The sample size for this study was determined following Jung [29].

$$n = Z^2p(1-p) / d^2$$

where  $n$  represents the required sample size,  $Z$  is the standard normal deviation at a 95% confidence level (1.96),  $p$  is the expected prevalence of KAP regarding food safety among poultry vendors (assumed to be 0.50), and  $d$  is the desired absolute precision (0.05).

Since there was no prior KAP data specific to poultry vendors in Mymensingh district, the expected prevalence ( $p$ ) was conservatively set at 0.50. This choice maximizes the sample size and is a common approach when the effect size or true prevalence is unknown, helping to ensure adequate statistical precision and power. As a result, the initial calculated sample size was 385.

Although vendors were recruited from multiple markets, a formal design effect was not applied because individual vendors, rather than markets, were treated as the primary sampling units. Random selection was conducted within each market to minimize intra-cluster correlation. To account for a potential non-response rate of approximately 5% and to improve the robustness of subgroup analyses, the sample size was increased to 410 vendors across the five upazilas. This enlarged sample was considered adequate to detect meaningful differences in KAP outcomes across education and experience strata and to enhance the representativeness of the target population, even though a formal effect-size-based power analysis was not feasible due to the exploratory nature of the study and the lack of comparable regional data.

### Study population and eligibility criteria

Poultry vendors were defined as individuals directly involved in live poultry sales, meat processing activities such as slaughtering and de-feathering, or related ancillary vending tasks within market environments. To ensure

consistent engagement in poultry-related trade, the study required vendors to have been operational for a minimum of three months prior to data collection.

Vendors were further classified based on their average daily sales volume into small-scale (fewer than 100 birds per day), medium-scale (100–200 birds per day), and large-scale (more than 200 birds per day). They were also categorized by market type (formal or informal) and whether they actively participated in poultry dressing practices. No maximum limit was set on experience, allowing vendors with less than 1 year to over 10 years of trade involvement to be included.

Only male vendors were identified in the study area; therefore, female vendors were not included. Part-time sellers, temporary workers, seasonal vendors, and individuals not directly involved in poultry handling or dressing activities were excluded from the study. Vendors who declined participation or were unable to provide informed consent were also excluded.

### **Questionnaire design and validation**

A structured questionnaire was developed based on a previously published study, with modifications made to ensure contextual relevance for poultry vendors in Bangladesh [5, 30]. The questionnaire was translated into Bengali and administered through face-to-face interviews using Google Forms for efficient data entry.

The questionnaire comprised four distinct sections. The first section contained 19 questions to collect information on the demographic and socioeconomic characteristics of the vendors, including age, location, education, income, type of poultry sold, years of vending experience, and source of poultry supply. The second section assessed knowledge of food safety through 22 closed-ended questions with “yes” or “no” responses, covering topics such as personal hygiene, cross-contamination, zoonoses, foodborne pathogens (e.g., *Salmonella* and *E. coli*), antimicrobial resistance, proper waste disposal, and cleaning practices. The third section measured attitudes with 23 questions related to hygiene behaviors, PPE use, the importance of food safety training, and disease transmission risks. These were answered as “agree,” “disagree,” or “no idea.” The final section evaluated hygiene practices through 14 yes/no questions concerning behaviors such as handwashing, cleaning of equipment and utensils, drainage systems, and shop sanitization.

Each section used a scoring system to measure responses. For the knowledge, attitude, and practice areas, a score of one was given for each correct or suitable answer, and zero for incorrect or unsuitable answers. A respondent was considered to have “appropriate” knowledge, attitude, or practice if at least 60% of the questions in that section were answered correctly.

The questionnaire was evaluated by a panel of five experts, including two microbiologists, two epidemiologists, and one public health specialist, to ensure reliability and validity. Content validity was measured using the Content Validity Index (CVI), with I-CVI values from 0.80 to 1.00 and a scale-level CVI (S-CVI/Ave) above the recommended threshold of 0.90, showing excellent content validity. Face validity was tested through pilot testing with 30 poultry vendors. Three questions were reworded for clarity based on pilot feedback, and two were removed due to ambiguity or redundancy. Cronbach’s alpha assessed reliability, with values of 0.78 for knowledge, 0.72 for attitude, and 0.69 for practice, indicating acceptable internal consistency. Exploratory factor analysis confirmed construct validity, and test–retest reliability showed good temporal stability of responses.

### **Data collection procedures**

Five trained interviewers underwent intensive training on standardized data collection procedures for two days to reduce interviewer bias and ensure consistent questionnaire administration. Interviewers were instructed to use neutral language and avoid prompting. A scripted Bengali version of the questionnaire was read aloud to vendors to accommodate varying literacy levels. Vendors were randomly selected within markets using a stratified random sampling approach and interviewed individually and privately to avoid peer influence.

During the interviews, vendors were assured that their responses would stay anonymous and confidential. To reduce social desirability bias, behavior-related questions were asked in a neutral and non-judgmental way, for example, “How often do you wash knives?” instead of “Do you wash your knives properly?”. Direct observation of hygiene behaviors was not conducted due to logistical issues; therefore, all practice data were self-reported. However, efforts were made to improve reliability by stressing confidentiality and using non-leading, behavior-specific questions.

### **Data management and statistical analysis**

Data on poultry vendors’ KAP regarding food safety were analyzed using R version 4.4.1 (The R Foundation for Statistical Computing, Vienna, Austria). To ensure data integrity, incomplete or missing responses were

excluded from the analysis because the proportion of missing data was minimal, and imputation was not considered necessary.

The reliability of the pilot-tested questionnaire, which included 30 vendors, was assessed using Cohen's  $\kappa$  statistic with the kappa2() function from the IRR package (R software), indicating strong inter-rater agreement. Descriptive statistics, such as frequencies and proportions of sociodemographic variables and KAP responses, were calculated using the tab1() function from the epiDisplay package. Radar charts were created in Microsoft Excel 2010 to visually summarize vendor responses across multiple KAP questions.

Associations between sociodemographic factors (age, education, experience, income, and vendor scale) and KAP outcomes were initially evaluated using Pearson's chi-square test (chisq.test() function, stats package). Variables with  $p \leq 0.20$  were considered for inclusion in multivariable logistic regression models. Multicollinearity was checked using the variance inflation factor (VIF), and variables with  $VIF > 10$  were considered for removal or adjustment. Stepwise forward and backward selection at a significance level of 0.05 was used to identify the most important predictors. Potential interaction effects between key predictors, such as education  $\times$  experience, were also examined; however, none were statistically significant and were not included in the final models. Final models were chosen based on the lowest Akaike Information Criterion to improve model fit while controlling for confounding effects.

## RESULTS

### Demographic and socioeconomic characteristics of the poultry vendors

The sociodemographic characteristics of the 410 poultry vendors revealed that all participants were male, with the majority (60.98%) being young adults aged 21–40 years, and generally having low educational attainment. A considerable proportion of the vendors were illiterate (27.32%) or had only primary education (50.00%). None of the vendors had received formal training in food safety. Most vendors (50.73%) reported modest monthly incomes ranging from 5,000 to 10,000 BDT and had 4–5 years of experience in poultry vending (51.22%). They mainly sold broiler and Sonali chickens (39.27%), with daily sales ranging from fewer than 100 to 200 birds, and sourced their poultry primarily from wholesalers (56.59%) or farms (39.02%). Although 40.49% of vendors reported having a trade license, none had received formal food safety certification or training linked to licensing, indicating a regulatory gap between licensing and food safety compliance (Table 1).

**Table 1:** Demographic and socioeconomic characteristics of poultry vendors (N = 410) in Mymensingh district, Bangladesh.

Characteristics	Category	Frequency (n)	Percentage (%)
Location	Mymensingh Sadar	89	21.71
	Muktagacha	83	20.24
	Fulbaria	70	17.07
	Trishal	84	20.49
	Bhaluka	84	20.49
Age (years)	10–20	20	4.88
	21–30	250	60.98
	31–40	124	30.24
	41–50	11	2.68
	51–60	5	1.22
Sex	Male	410	100.00
	Female	0	–
Vendor type	Formal	260	63.41
	Informal	150	36.59
Education	Primary	205	50.00
	Secondary	87	21.22
	Higher secondary	6	1.46
	Graduation	0	–
	None	112	27.32
Monthly income (BDT)	<5000	95	23.17
	5000–10000	208	50.73
	10000–15000	89	21.71
	15000–20000	7	1.71
	>20000	4	0.98
	Not disclosed	7	1.71
Marital status	Married	242	59.02
	Unmarried	168	40.98
Have children	Yes	118	28.78

Characteristics	Category	Frequency (n)	Percentage (%)
School-going children	No	292	71.22
	Yes	63	15.37
Number of dependents	No	347	84.63
	<2	143	34.88
	2–3	200	48.78
	4–5	64	15.61
	>5	3	0.73
Residential area	Rural	300	73.17
	Urban	110	26.83
Religion	Hindus	0	–
	Christian	0	–
	Buddhist	0	–
	Others	0	–
Experience (years)	<1	57	13.90
	1–3	117	28.54
	4–5	210	51.22
	6–10	19	4.63
	>10	7	1.71
Trade license	Yes	166	40.49
	No	224	54.63
	Applied	20	4.88
Selling volume	<100	145	35.37
	100–199	177	43.17
	200–300	64	15.61
	>300	24	5.85
Type of poultry sold	Only broiler	123	30.00
	Only Sonali	39	9.51
	Only native	8	1.95
	Broiler and Sonali	161	39.27
	Broiler and native	5	1.22
	Sonali and native	31	7.56
	Broiler, Sonali, and native	43	10.49
Source	Direct farm	160	39.02
	Wholesaler	232	56.59
	Middleman	18	4.39
Operation time	Morning–evening	298	72.68
	Morning–afternoon	63	15.37
	Afternoon–evening	23	5.61
	Morning only	14	3.41
	Afternoon only	3	0.73
	Evening only	9	2.20
Training	Yes	0	–
	No	410	100.00

### Knowledge of food safety among poultry vendors

The proportion of poultry vendors who had adequate knowledge of food safety was 40.73% (n = 410). Insufficient understanding of food safety and foodborne diseases was evident from the proportion of correctly answered questions (Table 2). Vendors operating in informal and peri-urban markets were more likely to lack proper drainage, waste disposal systems, and hygienic facilities than those working in formal and semi-urban markets, which contributed to poorer hygiene practices.

**Table 2:** Association between food safety knowledge and the demographic and socioeconomic characteristics of poultry vendors in the Mymensingh district, Bangladesh.

Variable	Category	Inadequate n (%)	Adequate n (%)	p-value
Location (Upazila)	Bhaluka	48 (57.1)	36 (42.9)	0.97
	Fulbaria	43 (61.4)	27 (38.6)	
	Muktagacha	48 (57.8)	35 (42.2)	
	Mymensingh Sadar	54 (60.7)	35 (39.3)	
	Trishal	50 (59.5)	34 (40.5)	
Age (years)	10–20	12 (60.0)	8 (40.0)	0.14
	21–30	152 (60.8)	98 (39.2)	

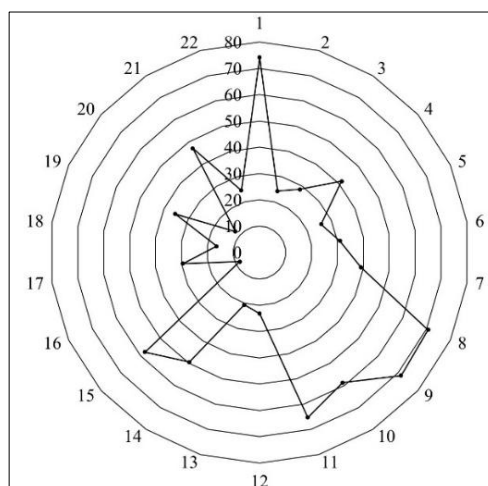
Variable	Category	Inadequate n (%)	Adequate n (%)	p-value
Education	31–40	74 (59.7)	50 (40.3)	<0.001*
	>40	5 (31.3)	11 (68.8)	
	None	101 (90.2)	11 (9.8)	
	Primary	132 (64.4)	73 (35.6)	
Vendor type	Secondary to higher secondary	10 (10.8)	83 (89.2)	0.36
	Formal	159 (61.2)	101 (38.8)	
Income (thousand BDT)	Informal	84 (56.0)	66 (44.0)	0.51
	<5	56 (54.9)	46 (45.1)	
	5–10	129 (62.0)	79 (38.0)	
	10–15	53 (59.6)	36 (40.4)	
Marital status	>15	5 (45.5)	6 (54.5)	0.54
	Married	140 (57.9)	102 (42.1)	
Having children	Unmarried	103 (61.3)	65 (38.7)	0.02*
	Yes	59 (50.0)	59 (50.0)	
School-going children	No	184 (63.0)	108 (37.0)	0.42
	Yes	34 (54.0)	29 (46.0)	
Number of dependents	No	209 (60.2)	138 (39.8)	0.74
	<2	86 (60.1)	57 (39.9)	
	2–3	115 (57.5)	85 (42.5)	
	4–5	41 (64.1)	23 (35.9)	
Area	>5	1 (33.3)	2 (66.7)	1.00
	Urban	65 (59.1)	45 (40.9)	
Experience (years)	Rural	178 (59.3)	122 (40.7)	0.32
	<1	40 (70.2)	17 (29.8)	
	1–3	66 (56.4)	51 (43.6)	
	4–5	121 (57.6)	89 (42.4)	
Trade license	Applied	10 (50.0)	10 (50.0)	0.62
	No	136 (60.7)	88 (39.3)	
Selling volume	Yes	97 (58.4)	69 (41.6)	0.72
	<100	86 (59.3)	59 (40.7)	
	100–200	108 (61.0)	69 (39.0)	
	200–300	34 (53.1)	30 (46.9)	
Poultry type	>300	15 (62.5)	9 (37.5)	0.60
	Broiler, Sonali, and native	26 (54.2)	22 (45.8)	
	Broiler and Sonali	103 (64.0)	58 (36.0)	
	Broiler only	71 (57.7)	52 (42.3)	
	Sonali and native	22 (56.4)	17 (43.6)	
Poultry source	Sonali only	21 (53.8)	18 (46.2)	0.34
	Direct farm	99 (61.9)	61 (38.1)	
	Middleman	8 (44.4)	10 (55.6)	
	Wholesaler	136 (58.6)	96 (41.4)	
Operation time	Morning only	8 (57.1)	6 (42.9)	0.89
	Morning–evening	213 (59.0)	148 (41.0)	
	Evening only	235 (59.3)	161 (40.7)	

Significant associations ( $p < 0.05$ ) are indicated by an asterisk (\*).

### Knowledge of food safety among poultry vendors

Most vendors showed familiarity with general food safety concerns (74.15%) and possessed adequate knowledge of key hygiene practices, including proper cleaning and sanitation of knives and cutting boards (70.73%), using gloves during poultry dressing (71.46%), and regularly disinfecting shops to decrease microbial contamination (Figure 2).

However, the vendors displayed limited knowledge of several key aspects of food safety. Many respondents were unaware of the risks related to consuming food or water in the shop (49.51%), improper disposal of poultry waste (57.80%), and the significance of regular veterinary check-ups (47.07%). Awareness of zoonotic diseases, antimicrobial resistance, and contamination risks to poultry and vendors was especially low. Knowledge of specific pathogens such as *E. coli* (19.02%) and *Salmonella* (16.34%) was also limited. Additionally, understanding of cross-contamination (8.29%) and the role of poor hygiene in disease spread (12.20%) was minimal (Table 3).



**Figure 2:** Knowledge assessment of poultry vendors based on responses to the study questionnaire. (1) Have you heard of food hygiene? (Yes/No); (2) Are you aware of antimicrobial resistance? (Yes/No); (3) Are you aware of zoonosis, meaning diseases that can be transmitted from animals to humans? (Yes/No); (4) Are you familiar with foodborne pathogens? (Yes/No); (5) Can foodborne pathogens infect poultry during dressing (meat processing)? (Yes/No); (6) Can dressed poultry be contaminated with foodborne pathogens? (Yes/No); (7) Can vendors be contaminated with foodborne pathogens? (Yes/No); (8) Can proper cleaning and sanitation of knives and cutting boards reduce the risk of exposure and transmission of poultry-related pathogens? (Yes/No); (9) Does using gloves during dressing reduce the risk of exposure to humans? (Yes/No); (10) Can regular cleaning of knives and chopping boards reduce microbial contamination? (Yes/No); (11) Can regular cleaning and disinfection of shops reduce microbial spread? (Yes/No); (12) Can insects, pests, and rodents be sources of contamination of dressed poultry? (Yes/No); (13) Can foodborne pathogens cause diarrhea in vendors? (Yes/No); (14) Does eating or drinking in the shop increase the risk of foodborne pathogen introduction? (Yes/No); (15) Does proper disposal of poultry waste (offal) reduce microbial spread and contamination? (Yes/No); (16) Can microorganisms be transmitted to dressed poultry from vendors' hands or utensils through cross-contamination? (Yes/No); (17) Does changing carcass dressing water reduce microbial contamination and transmission? (Yes/No); (18) Have you heard of foodborne illness? (Yes/No); (19) Have you heard about germs or microorganisms? (Yes/No); (20) Can inadequate food hygiene cause disease? (Yes/No); (21) Is regular poultry check-up by a veterinarian necessary? (Yes/No); (22) Does food hygiene awareness help prevent foodborne illness? (Yes/No).

**Table 3:** Summary of poultry vendors' food hygiene knowledge (N = 410) in the study areas of Mymensingh district, Bangladesh.

No. Statements	Adequate n (%)	Inadequate n (%)
1 Have you heard of food hygiene?	304 (74.15)	106 (25.85)
2 Source of information on food hygiene		
Radio	96 (23.41)	—
Television	175 (42.68)	—
Newspaper	58 (14.15)	—
Health service provider	41 (10.00)	—
Others	40 (9.76)	—
3 Are you aware of antimicrobial resistance?	100 (24.39)	310 (75.61)
4 Are you aware of zoonosis (disease transmitted from animals to humans)?	117 (28.54)	293 (71.46)
5 Are you familiar with foodborne pathogens?	170 (41.46)	240 (58.54)
6 Foodborne pathogens can infect poultry during dressing (processing).	106 (25.85)	304 (74.15)
7 Dressed poultry can be contaminated with foodborne pathogens.	127 (30.98)	283 (69.02)
8 Vendors can be contaminated with foodborne pathogens.	160 (39.02)	250 (60.98)
9 Proper knife and cutting board sanitation reduces pathogen transmission risk.	290 (70.73)	120 (29.27)
10 Using gloves during dressing reduces risk of human exposure.	293 (71.46)	117 (28.54)
11 Regular cleaning of knives and chopping boards reduces contamination.	241 (58.78)	169 (41.22)
12 Cleaning and disinfecting shops reduces microbial spread.	268 (65.37)	142 (34.63)
13 Insects, pests, and rodents may contaminate poultry.	95 (23.17)	315 (76.83)
14 Foodborne pathogens can cause diarrhea in vendors.	85 (20.73)	325 (79.27)
15 Eating or drinking in the shop increases contamination risk.	203 (49.51)	207 (50.49)
16 Proper disposal of poultry waste reduces contamination risk.	237 (57.80)	173 (42.20)
17 Cross-contamination can occur from hands or utensils.	34 (8.29)	376 (91.71)
18 Changing dressing water reduces microbial contamination.	121 (29.51)	289 (70.49)
19 Have you heard of foodborne illness?	68 (16.59)	342 (83.41)
20 Have you heard about germs/microorganisms?	145 (35.37)	265 (64.63)

No. Statements	Adequate n (%)	Inadequate n (%)
<i>Escherichia coli</i>	78 (19.02)	332 (80.98)
<i>Salmonella</i>	67 (16.34)	343 (83.66)
21 Inadequate hygiene can cause disease.	50 (12.20)	360 (87.80)
22 Poultry requires regular veterinary check-up.	193 (47.07)	217 (52.93)
23 Food hygiene awareness prevents foodborne illness.	101 (24.63)	309 (75.37)

### Food safety attitude of the poultry vendors

In this study, 42.68% of the vendors showed a generally positive attitude toward food safety. Most participants recognized the importance of maintaining hygiene during poultry dressing (64.15%), including regular handwashing (65.59%), keeping shops and utensils clean (68.54%), and using clean knives and cutting boards (70.73%). Vendors also identified potential sources of contamination, such as knives, dressing water, and cutting boards, and acknowledged the role of PPE in reducing microbial risks (Table 4).

**Table 4:** Association of demographic and socioeconomic variables with food hygiene attitude among poultry vendors.

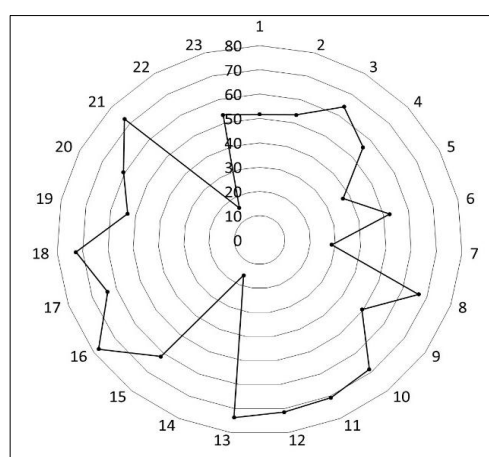
Variable	Category	Inadequate n (%)	Adequate n (%)	p-value
Upazila	Bhaluka	45 (53.6)	39 (46.4)	0.97
	Fulbaria	39 (55.7)	31 (44.3)	
	Muktagacha	49 (59.0)	34 (41.0)	
	Mymensingh Sadar	54 (60.7)	35 (39.9)	
	Trishal	48 (57.1)	36 (42.9)	
Age (years)	10–20	12 (60.0)	8 (40.0)	0.20
	21–30	137 (54.8)	113 (45.2)	
	31–40	73 (58.9)	51 (41.1)	
	>40	13 (81.2)	3 (18.8)	
Education	None	69 (61.6)	43 (38.4)	0.01*
	Primary	103 (50.2)	102 (49.8)	
	Secondary to higher secondary	63 (67.7)	30 (32.3)	
Vendor type	Formal	146 (56.2)	114 (43.8)	0.60
	Informal	89 (59.3)	61 (40.7)	
Income (thousand BDT)	<5	59 (57.8)	43 (42.2)	0.35
	5–10	126 (60.6)	82 (39.4)	
	10–15	44 (49.4)	45 (50.6)	
	>15	6 (54.5)	5 (45.5)	
Marital status	Married	137 (56.6)	105 (43.4)	0.80
	Unmarried	98 (58.3)	70 (41.7)	
Having children	Yes	64 (54.2)	54 (45.8)	0.48
	No	171 (58.6)	121 (41.4)	
School-going children	Yes	34 (54.0)	29 (46.0)	0.66
	No	201 (57.9)	146 (42.1)	
Dependents	<2	83 (58.0)	60 (42.0)	0.92
	2–3	115 (57.5)	85 (42.5)	
	>4	37 (55.2)	30 (44.8)	
Area	Urban	71 (64.5)	39 (35.5)	0.09
	Rural	164 (54.7)	136 (45.3)	
Experience (years)	<1	27 (47.4)	30 (52.6)	0.10
	2–3	63 (53.8)	54 (46.2)	
	4–5	132 (62.9)	78 (37.1)	
	>5	13 (50.0)	13 (50.0)	
Trade license	Applied	15 (75.0)	5 (25.0)	0.22
	No	129 (57.6)	95 (42.4)	
	Yes	91 (54.8)	75 (45.2)	
Selling volume	<100	81 (55.9)	64 (44.1)	0.29
	100–200	110 (62.1)	67 (37.9)	
	200–300	32 (50.0)	32 (50.0)	
	>300	12 (50.0)	12 (50.0)	
Poultry type	Broiler, Sonali, native	28 (58.3)	20 (41.7)	<0.001*
	Broiler and Sonali	110 (68.3)	51 (31.7)	

Variable	Category	Inadequate n (%)	Adequate n (%)	p-value
Poultry source	Broiler only	58 (47.2)	65 (52.8)	0.34
	Sonali and native	12 (30.8)	27 (69.2)	
	Sonali only	27 (69.2)	12 (30.8)	
	Direct farm	92 (57.5)	68 (42.5)	
	Middleman	12 (66.7)	6 (33.3)	
Operation time	Wholesaler	131 (56.5)	101 (43.5)	0.67
	Morning only	9 (64.3)	5 (35.7)	
	Morning-evening	208 (57.6)	153 (42.4)	
	Evening only	18 (51.4)	17 (48.6)	

Significant associations ( $p < 0.05$ ) are indicated by an asterisk (\*).

### Food hygiene attitude of poultry vendors

The majority of vendors agreed that individuals suffering from foodborne illness, such as diarrhea, or other health conditions, including respiratory symptoms or fever, should not be allowed to work in the processing area. In addition, a considerable proportion of vendors believed that it is more appropriate to supply dressed poultry in hygienic bags or packets rather than in polyethylene bags. Many vendors also recognized the importance of properly disposing of water used for washing utensils and equipment. Furthermore, most vendors expressed willingness to change incorrect food handling practices when informed, and the majority agreed that toxic chemicals and cleaning solutions should be stored away from the processing area. Most vendors also acknowledged that good personal hygiene can help prevent foodborne illness (Figure 3).



**Figure 3:** Distribution of food hygiene attitudes among poultry vendors based on questionnaire responses. (1) Safe food handling is an important part of your job responsibility (Agree/Disagree/No idea); (2) Learning more about food safety is important to you (Agree/Disagree/No idea); (3) Foodborne pathogens can be transmitted easily during poultry dressing (Agree/Disagree/No idea); (4) Foodborne pathogens have detrimental effects on human health (Agree/Disagree/No idea); (5) Microbial spread can be reduced by proper hygiene and sanitation (Agree/Disagree/No idea); (6) Food safety training can reduce the spread of foodborne illness (Agree/Disagree/No idea); (7) Vendors with wounds or injuries should not be involved in poultry processing (Agree/Disagree/No idea); (8) Handwashing before dressing reduces contamination risk (Agree/Disagree/No idea); (9) Safe meat handling is part of vendor responsibility (Agree/Disagree/No idea); (10) Keeping shop and utensils clean reduces foodborne illness risk (Agree/Disagree/No idea); (11) Using clean knives and cutting boards reduces contamination risk (Agree/Disagree/No idea); (12) Knives, dressing water, and cutting boards may cause carcass contamination (Agree/Disagree/No idea); (13) Wearing PPE (gloves, apron, mask, cap) reduces contamination risk (Agree/Disagree/No idea); (14) Vendors with cuts should not process poultry without gloves (Agree/Disagree/No idea); (15) Chemicals should be stored away from the processing area (Agree/Disagree/No idea); (16) Sick workers should not work in the processing area (Agree/Disagree/No idea); (17) Water used for washing utensils should be disposed properly (Agree/Disagree/No idea); (18) Hygienic bags should be used instead of polyethylene bags (Agree/Disagree/No idea); (19) Food safety awareness reduces contamination risk (Agree/Disagree/No idea); (20) Good personal hygiene prevents foodborne illness (Agree/Disagree/No idea); (21) Willingness to change incorrect food handling practices (Agree/Disagree/No idea); (22) Environmental conditions are suitable for vending (Agree/Disagree/No idea); (23) Health inspectors should regularly monitor vending practices (Agree/Disagree/No idea).

### Factors associated with improper attitudes toward food safety

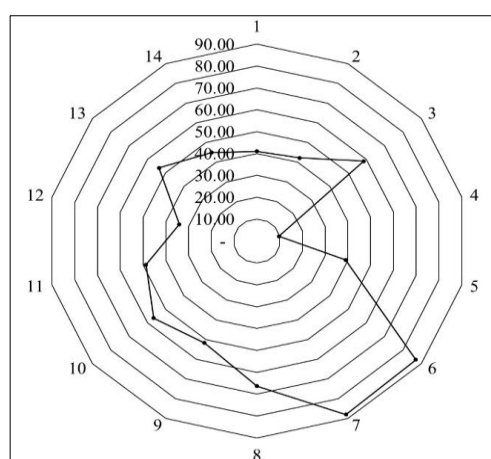
Overall, the majority of vendors demonstrated a positive attitude toward food safety (51.71%), recognizing it as an important responsibility in their work and acknowledging the importance of training and awareness in

reducing the spread of foodborne illness (52.44%). A considerable proportion of vendors also supported safe meat handling practices (49.51%), recognized the role of food safety awareness in preventing contamination (53.17%), and agreed that regular monitoring by health inspectors is necessary (53.41%) (Table 5).

**Table 5:** Summary of the food hygiene attitude of poultry vendors (N = 410) in the study areas of Mymensingh district, Bangladesh.

No.	Statements	Appropriate n (%)	Inappropriate n (%)
1	Safe food handling is an important job responsibility	212 (51.71)	198 (48.29)
2	Learning more about food safety is important	219 (53.41)	191 (46.59)
3	Foodborne pathogens can be transmitted during poultry dressing	263 (64.15)	147 (35.85)
4	Foodborne pathogens have harmful effects on human health	229 (55.85)	181 (44.15)
5	Microbial spread can be reduced by proper hygiene and sanitation	152 (37.07)	258 (62.93)
6	Food safety training reduces foodborne illness	215 (52.44)	195 (47.56)
7	Vendors with wounds should not handle poultry	117 (28.54)	293 (71.46)
8	Handwashing before dressing reduces contamination	273 (66.59)	137 (33.41)
9	Safe meat handling is vendor responsibility	203 (49.51)	207 (50.49)
10	Keeping shop and utensils clean reduces risk	281 (68.54)	129 (31.46)
11	Clean knives and cutting boards reduce contamination	290 (70.73)	120 (29.27)
12	Knives, dressing water, cutting boards may contaminate carcass	293 (71.46)	117 (28.54)
13	PPE (gloves, apron, mask, cap) reduces contamination risk	302 (73.66)	108 (26.34)
14	Vendors with cuts should not dress poultry without gloves	65 (15.85)	345 (84.15)
15	Chemicals should be stored away from processing area	253 (61.71)	157 (38.29)
16	Sick workers should not work in processing area	319 (77.80)	91 (22.20)
17	Washing water should be disposed properly	261 (63.66)	149 (36.34)
18	Hygienic bags should be used instead of polyethylene	298 (72.68)	112 (27.32)
19	Food safety awareness reduces contamination risk	218 (53.17)	192 (46.83)
20	Personal hygiene prevents foodborne illness	248 (60.49)	162 (39.51)
21	Willing to change incorrect food handling practices	299 (72.93)	111 (27.07)
22	Environmental conditions are suitable for vending	63 (15.37)	347 (84.63)
23	Health inspectors should monitor vending regularly	219 (53.41)	191 (46.59)

However, a significant number of vendors exhibited inappropriate attitudes, including a lack of recognition of the importance of proper hygiene, avoiding handling poultry when injured, and failing to maintain suitable environmental conditions at vending sites (Figure 4). Logistic regression analysis identified poultry type and education level as key factors linked to improper attitudes toward food safety (Table 6).



**Figure 4:** Distribution of food hygiene practices among poultry vendors based on questionnaire responses. (1) Do you wash your hands before slaughtering and dressing poultry? (Yes/No); (2) Do you wash slaughtering equipment before processing poultry? (Yes/No); (3) Do you wash slaughtering equipment after processing poultry? (Yes/No); (4) Do you wear PPE (gloves, apron, mask, cap) while slaughtering and dressing poultry? (Yes/No); (5) Do you wash your hands with soap/detergent before processing poultry? (Yes/No); (6) Do you wash your hands with soap/detergent after processing poultry? (Yes/No); (7) Do you wash your hands with soap/detergent after using the toilet? (Yes/No); (8) Do you wash contact surfaces with soap/detergent before processing poultry? (Yes/No); (9) Do you have proper drainage and waste management facilities in your shop? (Yes/No); (10) Do you change carcass dressing water regularly? (Yes/No); (11) Do you disinfect your shop at closing time? (Yes/No); (12) Do you process poultry when you feel sick? (Yes/No); (13) Do vendors need food hygiene training? (Yes/No); (14) Do inspectors or environmental health workers monitor vending practices? (Yes/No).

**Table 6:** Factors associated with improper attitudes toward food safety.

Variable	Category	Estimate ± SE	Odds ratio (95% CI)	p-value
Poultry type	Sonali and native	Reference	Reference	—
	Broiler, Sonali, and native	1.20 ± 0.46	3.32 (1.34–8.21)	0.009*
	Broiler and Sonali	1.68 ± 0.39	5.38 (2.47–11.69)	<0.001*
	Broiler only	0.85 ± 0.40	2.33 (1.06–5.11)	0.03*
	Sonali only	1.79 ± 0.50	5.86 (2.19–15.67)	<0.001*
Education	Primary	Reference	Reference	—
	None	0.31 ± 0.25	1.37 (0.83–2.24)	0.20
	Secondary to higher secondary	0.82 ± 0.27	2.27 (1.32–3.91)	0.003*

Estimated values are presented as mean ± standard error. Significant associations ( $p < 0.05$ ) are indicated by an asterisk (\*).

### Food safety practices among poultry vendors in the Mymensingh district of Bangladesh

This study found that only 28.78% ( $n = 410$ ) of vendors had adequate food safety practices, while most showed poor hygiene behavior. About 90.24% of poultry vendors did not wear PPE, such as gloves, aprons, masks, and caps, during poultry slaughter and dressing. Most vendors reported washing their hands with soap or detergent after using the toilet. However, 59.98% of vendors did not wash their hands before handling poultry, although most washed their hands after dressing poultry. Additionally, a significant number of vendors washed contact surfaces with soap, detergent, and water before processing poultry (Table 7).

**Table 7:** Association of demographic and socioeconomic variables with food hygiene practices among poultry vendors.

Variable	Category	Inappropriate n (%)	Appropriate n (%)	p-value
Upazila	Bhaluka	64 (76.2)	20 (23.8)	0.12
	Fulbaria	43 (61.4)	27 (38.6)	
	Muktagacha	57 (68.7)	26 (31.3)	
	Mymensingh Sadar	70 (78.7)	19 (21.3)	
	Trishal	58 (69.0)	26 (31.0)	
Age (years)	10–20	12 (60.0)	8 (40.0)	0.67
	21–30	178 (71.2)	72 (28.8)	
	31–40	91 (73.4)	33 (26.6)	
	>40	11 (68.8)	5 (31.2)	
Education	None	81 (72.3)	31 (27.7)	0.58
	Primary	149 (72.7)	56 (27.3)	
	Secondary to higher secondary	62 (66.7)	31 (33.3)	
Vendor type	Formal	190 (73.1)	70 (26.9)	0.32
	Informal	102 (68.0)	48 (32.0)	
Income (thousand BDT)	<5	68 (66.7)	34 (33.3)	0.36
	5–10	150 (72.1)	58 (27.9)	
	10–15	64 (71.9)	25 (28.1)	
	>15	10 (90.9)	1 (9.1)	
Marital status	Married	173 (71.5)	69 (28.5)	0.97
	Unmarried	119 (70.8)	49 (29.2)	
Having children	Yes	83 (70.3)	35 (29.7)	0.89
	No	209 (71.6)	83 (28.4)	
School-going children	Yes	48 (76.2)	15 (23.8)	0.42
	No	244 (70.3)	103 (29.7)	
Dependents	<2	102 (71.3)	41 (28.7)	0.31
	2–4	141 (70.5)	59 (29.5)	
	>4	49 (73.1)	18 (26.9)	
Area	Urban	83 (75.5)	27 (24.5)	0.30
	Rural	209 (69.7)	91 (30.3)	
Experience (years)	<1	35 (61.4)	22 (38.6)	0.20
	1–3	90 (76.9)	27 (23.1)	
	4–5	149 (71.0)	61 (29.0)	
	>5	18 (69.2)	8 (30.8)	
Trade license	Applied	13 (65.0)	7 (35.0)	0.81
	No	161 (71.9)	63 (28.1)	
	Yes	118 (71.1)	48 (28.9)	
Selling volume	<100	102 (70.3)	43 (29.7)	0.53
	100–200	123 (69.5)	54 (30.5)	
	200–300	47 (73.4)	17 (26.6)	
Poultry type	Broiler, Sonali, native	39 (81.2)	9 (18.8)	<0.001*

Variable	Category	Inappropriate n (%)	Appropriate n (%)	p-value
Poultry source	Broiler and Sonali	125 (77.6)	36 (22.4)	0.35
	Broiler only	79 (64.2)	44 (35.8)	
	Sonali and native	31 (79.5)	8 (20.5)	
	Sonali only	18 (46.2)	21 (53.8)	
	Direct farm	110 (68.8)	50 (31.2)	
	Middleman	11 (61.1)	7 (38.9)	
Operation time	Wholesaler	171 (73.7)	61 (26.3)	0.96
	Morning only	10 (71.4)	4 (28.6)	
	Morning–evening	256 (70.9)	105 (29.1)	
	Evening only	26 (74.3)	9 (25.7)	

Significant associations ( $p < 0.05$ ) are indicated by an asterisk (\*).

### Food hygiene practices among poultry vendors

Most poultry vendors reported that they regularly washed their slaughtering and dressing equipment after processing poultry. However, only 56.59% of vendors stated that they changed the carcass dressing water regularly. Approximately half of the vendors' shops lacked proper drainage and waste management facilities. In addition, most vendors did not clean their shops with disinfectants at the end of the day (Figure 4, Table 8).

**Table 8:** Summary of food hygiene practices among poultry vendors (N = 410) in the study areas of Mymensingh district, Bangladesh.

No.	Statements	Appropriate n (%)	Inappropriate n (%)
1	Do you always wash your hands before slaughtering and dressing poultry?	168 (40.98)	242 (59.02)
2	Do you always wash slaughtering and dressing equipment before processing poultry?	173 (42.20)	237 (57.80)
3	Do you always wash slaughtering and dressing equipment after processing poultry?	240 (58.54)	170 (41.46)
4	Do you wear PPE (gloves, apron, mask, cap) while slaughtering and dressing poultry?	40 (9.76)	370 (90.24)
5	Do you wash your hands with soap/detergent before processing poultry?	160 (39.02)	250 (60.98)
6	Do you wash your hands with soap/detergent after processing poultry?	357 (87.07)	53 (12.93)
7	Do you wash your hands with soap/detergent after using the toilet?	361 (88.05)	49 (11.95)
8	Do you wash contact surfaces with soap/detergent and water before processing?	272 (66.34)	138 (33.66)
9	Do you have proper drainage and waste management facilities in your shop?	212 (51.71)	198 (48.29)
10	Do you change carcass dressing water regularly?	232 (56.59)	178 (43.41)
11	Do you clean and disinfect your shop at closing time?	200 (48.78)	210 (51.22)
12	Do you process poultry when you feel sick?	140 (34.15)	270 (65.85)
13	Do you think vendors should receive food hygiene training?	220 (53.66)	190 (46.34)
14	Do inspectors / environmental health workers inspect your vending process?	184 (44.88)	226 (55.12)

The variable “Upazila” indicates that vendors from Bhaluka and Mymensingh Sadar were more likely to engage in improper food safety practices compared with vendors from Fulbaria. Vendors from Bhaluka had an odds ratio of 2.1, indicating more than double the risk, whereas vendors from Mymensingh Sadar had an odds ratio of 2.4, indicating almost 2.5 times higher risk. The odds ratios for Muktagacha and Trishal were lower and not statistically significant. Vendors selling Sonali and native poultry, as well as mixed poultry types (Broiler, Sonali, and native; Broiler and Sonali; Broiler only), showed a significantly higher likelihood of engaging in improper food safety practices, with odds ratios ranging from 2.2 to 5.2 (Table 9).

**Table 9:** Factors associated with improper food safety practices.

Variable	Category	Estimate $\pm$ SE	Odds ratio (95% CI)	p-value
Upazila	Fulbaria	Reference	Reference	—
	Bhaluka	0.72 $\pm$ 0.36	2.1 (1.0–4.2)	0.04*
	Muktagacha	0.32 $\pm$ 0.35	1.4 (0.7–2.8)	0.35
	Mymensingh Sadar	0.86 $\pm$ 0.36	2.4 (1.2–4.9)	0.01*
	Trishal	0.37 $\pm$ 0.35	1.4 (0.7–2.9)	0.29
Poultry type	Sonali only	Reference	Reference	—
	Sonali and native	1.52 $\pm$ 0.51	4.6 (1.7–12.6)	0.003*
	Broiler, Sonali, and native	1.64 $\pm$ 0.49	5.2 (1.9–13.7)	<0.001*
	Broiler and Sonali	1.41 $\pm$ 0.37	4.1 (1.9–8.7)	<0.001*
	Broiler only	0.75 $\pm$ 0.37	2.2 (1.0–4.5)	0.04*

Estimated values are presented as mean  $\pm$  standard error. Significant associations ( $p < 0.05$ ) are indicated by an asterisk (\*).

## DISCUSSION

### Novelty and overall significance of the study

This study evaluated the KAP of poultry vendors regarding food safety and pathogen contamination during poultry dressing in five upazilas in Mymensingh, Bangladesh. To our knowledge, this is the first comprehensive assessment of KAP among poultry vendors in Mymensingh, one of Bangladesh's main poultry production hubs, using a large stratified sample and validated questionnaires with high reliability scores. Unlike previous studies that focused on Dhaka or relied on convenience sampling, our findings reveal significant systemic gaps, including the lack of food safety training for all vendors and a notable knowledge–practice gap.

This study offers original evidence for developing targeted interventions by connecting vendor education and experience with hygiene practices. Additionally, placing poultry vendor practices within a One Health framework highlights their role in zoonotic disease transmission and antimicrobial resistance, broadening the relevance of the findings to global food safety and public health discussions beyond Bangladesh.

### Demographic characteristics and occupational profile of poultry vendors

The dominance of male vendors highlights gender-specific occupational trends in poultry vending. The prevalence of vendors in their 20s and 30s suggests that poultry vending is a common livelihood for younger adults [31]. Low educational attainment, with many vendors being illiterate or having only primary education, limits the adoption of advanced food safety practices [32, 33]. Multivariable logistic regression analysis further demonstrated a clear education gradient, with vendors possessing secondary or higher education showing significantly better food safety practices compared to illiterate vendors (adjusted odds ratios >1,  $p < 0.05$ ), even after controlling for age, income, market type, and years of experience.

The lack of formal food safety training among vendors highlights a systemic gap that could hinder efforts to enhance hygiene and decrease foodborne risks [7, 23].

### Economic constraints and market structure

Although most vendors had moderate incomes, many earned below subsistence level, limiting their ability to invest in improved food safety tools and practices [34]. Low income further restricts vendors' capacity to adopt essential hygiene practices, such as purchasing PPE, disinfectants, or proper waste disposal equipment, thereby perpetuating unsafe handling and contamination risks.

Most vendors had less than 10 years of experience, making them relatively new to the trade and possibly limiting their awareness of best practices in poultry handling [5, 35]. Their focus on broiler and Sonali chickens reflects market demand, while the absence of native poultry in broiler sales shows limited market diversity. Daily sales volumes indicate active trading but also reveal a lack of standardization in operational scale among vendors [36, 37].

The sourcing patterns, in which wholesalers dominate as suppliers, show reliance on centralized supply systems. However, the small number of vendors sourcing directly from farms indicates some level of direct involvement with production processes, which could be used to enhance traceability and food safety compliance [38]. This regional focus and supply chain mapping offer a unique contribution compared with earlier Dhaka-centered studies [5, 7].

### Knowledge gaps regarding food safety and foodborne diseases

The findings reveal a lack of knowledge about foodborne diseases among poultry vendors, with fewer than half demonstrating sufficient awareness [39]. The low rate of correct answers to questions on food safety indicates a poor understanding of public health risks. This limited awareness is worrying considering the important role vendors play in the food supply chain [32, 33].

The limited understanding of contamination sources, hygiene, and associated health risks reveals systemic gaps in education and training. Factors such as the lack of formal food safety training programs and limited access to resources probably contribute to this knowledge gap.

### Awareness of hygiene practices and contamination risks

A significant number of vendors demonstrated adequate knowledge of essential practices, including cleaning and sanitizing knives and cutting boards to lower pathogen exposure [5, 40]. This indicates partial awareness of preventive hygiene measures that are vital for reducing microbial contamination. Awareness of glove use during poultry dressing also shows some understanding of personal protective measures [30]. Vendors acknowledged the importance of regular utensil cleaning and disinfectant use in limiting microbial spread [41].

However, lower awareness of regularly cleaning knives and chopping boards reveals gaps in overall food safety knowledge [42, 43]. These gaps emphasize the need to evaluate specific contexts beyond previously studied urban centers, especially in areas outside of Dhaka [5, 7].

#### **Limited understanding of zoonoses, antimicrobial resistance, and environmental hygiene**

A small number of vendors understood the risks involved with eating food or drinking water at their shops, showing limited awareness of basic contamination ways [44]. Likewise, only about half acknowledged the importance of proper poultry waste disposal, indicating inconsistent knowledge of waste management practices [45].

Knowledge gaps also included the importance of regular veterinary check-ups, which were recognized by fewer than half of the vendors. This suggests limited understanding of the role of animal health in preventing zoonotic disease transmission [46]. Awareness of zoonoses and antimicrobial resistance was very low, highlighting a critical gap in the ability of ability to address public health risks.

These findings are concerning due to the potential for zoonotic disease transmission within the vendor–customer ecosystem [47, 48]. Limited knowledge of common pathogens like *E. coli* and *Salmonella*, along with poor awareness of cross-contamination risks, highlights the need for targeted microbiological safety training [49].

#### **Attitudes toward hygiene, sanitation, and food safety**

Most vendors were aware of the risks posed by foodborne pathogens during poultry dressing, indicating an understanding of the importance of proper handling to reduce contamination [49]. Recognizing handwashing as a preventive measure reflects an appreciation of basic hygiene practices, although consistent implementation remains uncertain [50].

Positive attitudes toward maintaining cleanliness in shops and equipment suggest that vendors may be willing to adopt improved sanitation measures when provided with proper training and resources [51, 52]. Recognizing that knives, dressing water, and cutting boards can be sources of contamination shows a basic understanding of cross-contamination risks. Agreement on the importance of PPE also indicates a willingness to implement protective measures [53].

#### **Perception of personal health, environmental hygiene, and workplace safety**

Most vendors understood that workers with illnesses such as diarrhea, respiratory symptoms, or fever should not work in processing areas, demonstrating awareness of contamination risks from sick personnel [54].

Preference for hygienic bags over polyethylene bags shows awareness of packaging hygiene [55, 56]. Recognizing proper wastewater disposal indicates understanding of environmental hygiene, and awareness that toxic chemicals should be stored away from processing areas reflects concern for workplace safety [57, 58].

Vendors' willingness to change incorrect food handling practices indicates a readiness to adopt safer methods when proper guidance and resources are provided [23, 59]. These behavioral insights from Mymensingh offer new evidence for customizing interventions in semi-urban markets, which differ from urban Dhaka markets in infrastructure and vendor practices [5, 7].

#### **Positive attitudes but incomplete understanding of hygiene importance**

Many vendors demonstrated a proactive attitude and recognized that safe food handling is part of their professional duty [5, 60]. Vendors valued training, awareness, and regular inspections as essential for maintaining food safety standards [23, 61].

However, the low proportion recognizing the direct link between hygiene and microbial contamination indicates incomplete understanding [7]. Similarly, reluctance to exclude injured workers from poultry handling reflects poor awareness of contamination risks [10]. These findings indicate the need for targeted training programs that connect hygiene to health outcomes [62, 63].

#### **Observed practices and gaps in hygiene behavior**

Practices among poultry vendors showed significant inconsistencies in following food safety protocols, especially concerning PPE use and hand hygiene. Many vendors did not wear PPE during slaughtering and dressing, raising the risk of contamination and workplace exposure [64].

Although most vendors washed their hands after dressing poultry, fewer washed their hands before handling poultry, which indicates incomplete hygiene awareness [7, 65]. Cleaning contact surfaces before processing shows some understanding of sanitation but not full compliance [66, 67].

### **Equipment hygiene, waste management, and environmental risks**

More than half of vendors cleaned their equipment regularly, demonstrating awareness of the importance of tool hygiene in reducing contamination [67, 68]. However, failing to change dressing water regularly increases the risk of microbial spread.

Inadequate drainage and waste management in many shops pose significant challenges to maintaining hygienic conditions. Poor waste disposal attracts pests and raises the risk of environmental contamination [69]. Not disinfecting shops at the end of the day further elevates contamination risks [70].

### **Associations between demographic factors and hygiene practices**

Chi-square analysis did not reveal significant relationships between knowledge, attitude, and practices overall. However, education level was significantly linked to knowledge and hygiene practices, including handwashing, utensil cleaning, and changing dressing water ( $p < 0.05$ ). Experience was connected to handwashing, utensil cleaning, and waste management practices ( $p < 0.05$ ). Age was also related to several hygiene behaviors, except PPE and sanitizer use.

These findings differ from some earlier studies that reported stronger links between education and food hygiene practices [23, 32, 33].

### **One Health implications and regulatory gaps**

The findings reveal significant gaps in vendor knowledge and practices that have implications for human, animal, and environmental health. Limited awareness of zoonoses and antimicrobial resistance raises the risk of pathogen transmission at the human–animal interface [71].

Poor waste disposal and drainage contribute to environmental contamination [5]. Despite existing regulations under the Bangladesh Food Safety Authority, enforcement is limited in semi-urban markets [5, 7].

A One Health approach that integrates veterinary oversight, public health education, and infrastructure development is necessary to reduce contamination risks [72, 73].

### **Practical recommendations for improving food safety**

Providing low-cost PPE, requiring training for licensing, and implementing mobile training programs could enhance hygiene practices [74, 75]. The current dataset offers a baseline for tracking progress and developing targeted interventions.

### **Study limitations**

This study had several limitations. Training history was not assessed, only male vendors were included, practices were self-reported, and findings may not be generalizable beyond Mymensingh. Despite these limitations, the study provides novel region-specific insights complementing earlier Dhaka-based studies.

## **CONCLUSION**

This study offers a comprehensive assessment of the KAP of poultry vendors concerning food safety and pathogen contamination in five upazilas of Mymensingh district, Bangladesh, a major hub for poultry production. The results revealed significant gaps in vendors' food safety knowledge and hygiene practices, despite generally positive attitudes toward safe food handling. Less than half of the vendors possessed adequate understanding of foodborne diseases, zoonoses, and antimicrobial resistance, and only a small percentage consistently followed recommended hygiene practices, such as wearing PPE, washing hands properly before handling poultry, and regularly disinfecting equipment and vending areas. Logistic regression analysis indicated that education level, type of poultry handled, and market location were key factors predicting poor hygiene practices, suggesting that both individual and environmental factors affect food safety behavior. These findings underscore a clear knowledge–practice gap, where vendors may recognize the importance of hygiene but fail to adopt safe practices due to limited training, resources, or inadequate market infrastructure.

From a practical perspective, the study highlights the urgent need for targeted food safety training programs for poultry vendors, especially in semi-urban and informal markets where regulatory oversight is limited. Providing low-cost PPE, improving drainage and waste disposal systems in local markets, and linking vendor licensing to mandatory food safety education could significantly lower the risk of foodborne pathogen transmission. The findings also support adopting a One Health approach, as unsafe poultry handling practices not only threaten consumer health but also contribute to environmental contamination and the spread of zoonotic pathogens and antimicrobial-resistant bacteria at the human–animal–environment interface. Strengths of this study include

using a large stratified sample, validated questionnaires with good reliability, and including vendors from multiple municipalities, which enhances the representativeness of the results compared to previous studies limited to urban settings.

Future studies should include direct observational assessments of hygiene practices, incorporate female vendors where present, and assess the effectiveness of structured training programs and regulatory enforcement over time. Extending similar research to other regions of Bangladesh and different types of traditional markets would enhance understanding of food safety risks in the poultry supply chain. In conclusion, improving food safety among poultry vendors requires coordinated efforts involving public health authorities, veterinary services, municipal agencies, and vendor communities. Strengthening education, infrastructure, and regulatory oversight within a One Health framework is vital to decrease foodborne illness risk, protect consumers, and create safer poultry marketing systems in Bangladesh and comparable settings.

#### **DATA AVAILABILITY**

All data are available within the manuscript included in the text, tables and figures. The raw data will be made available upon a valid request to the corresponding author.

#### **AUTHORS' CONTRIBUTIONS**

MAI: Conceptualization, methodology, investigation, data collection, data analysis, visualization, original draft preparation, and manuscript review and editing. NI: Methodology, data analysis, and manuscript review and editing. MAN: Methodology, investigation, original draft preparation, and manuscript review and editing. AKMZH: Methodology and manuscript review and editing. SSI: Methodology, data collection, data analysis, visualization, and manuscript review and editing. AKMAR: Methodology and manuscript review and editing. MFRK: Methodology and manuscript review and editing. SMLK: Supervision, conceptualization, methodology, investigation, funding acquisition, resource acquisition, original draft preparation, and manuscript review and editing. All authors have read and approved the final version of the manuscript.

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#### **COMPETING INTERESTS**

The authors declare that they have no competing interests.

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