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The Role of Risk Analysis in the Food Quality and Safety Management System in Bangladesh

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ABSTRACT

The increasing global demand for safe and high-quality food has intensified the need for robust Food Quality and Safety Management Systems (FQSMS). In Bangladesh, where food production and processing are vital to the economy, implementing effective risk analysis is critical. This manuscript explores the role of risk analysis in enhancing food quality and safety management systems in Bangladesh. It delves into the key components of risk analysis risk assessment, risk management, and risk communication and examines their application in identifying and mitigating potential hazards. Challenges in adopting risk analysis in Bangladesh, such as regulatory gaps, technological limitations, and capacity building, are discussed, alongside strategies for improvement. The study concludes with recommendations for fostering a more effective integration of risk analysis into the national food safety framework.

Keywords: *Risk Analysis, Food Quality, Food Safety Management System, Bangladesh, Risk Assessment, Risk Management, Risk Communication*

INTRODUCTION

Unsafe food is a global health concern and poses significant health risks worldwide. Due to the consumption of unsafe foods, globally millions of people fall ill, and hundreds of thousands die every year (Fung, Wang, & Menon, 2018). Accessing safe food promotes good health and saves lives (Fung, Wang, & Menon, 2018). Therefore, an integral part of food safety is to prevent contamination of food and thereby reduce the food borne illness (Luning & Devlieghere, 2006). Foodborne illnesses are mainly caused due to contamination of food with harmful bacteria, viruses, parasites, toxins or chemicals. Foodborne illness ranges from mild and self-limiting symptoms such as nausea, vomiting and diarrhea to life-threatening conditions such as kidney and liver failure and even cancer (WHO, 2016). Hence, food safety is a major concern for all stakeholders of the food system from the producer to the market place to the household (Wilcock, Pun, Khanona, & Aung, 2004).

Food safety is a shared responsibility (WHO, 2016); hence, the consumer plays a vital role to protect their health by selecting and adopting safe food during purchase and preparation (Basha & Lal, 2019). Previous study mentions that, consumers consider several factors such as freshness, quality when purchasing food (J. Ali, Kapoor, & Moorthy, 2010). Further, consumers exhibit different purchasing behaviours regarding safe food in different socioeconomic contexts (Wilcock et al., 2004). Therefore, understanding consumer attitude towards safe food is an important determinant for reducing foodborne illnesses and ensuring safe food in the food system of a community (Wilcock et al., 2004).

Bangladesh, a low middle income country (The World Bank, 2016b) has recently been concerned with food safety issues such as excess formalin in food and food adulteration. Further, the country is facing a growing burden of foodborne diarrhoeal illnesses (A. Ali, 2013). Several studies have been conducted related to food safety in this community however; there is limited published data on consumer knowledge, attitude and practice towards safe food in Bangladesh. Numerous developed and developing countries have conducted such studies for ensuring safe food and the better food safety management within their food system.

Objectives of the Research

To progress this current research aim, five objectives were formulated. They are:

1. To determine what the PHFP understands about safe food
2. To determine the importance of safe food to the PHFP including the reasons for level of importance.
3. To examine the strategies used by the PHFP to operationalise their understanding of safe food during their food purchasing decision making process.
4. To explore where the PHFP locate information about safe food.
5. To investigate the relationship between socioeconomic status and safe food perception, importance, information sources and consideration of safe food in food purchasing practices.

METHODOLOGY OF THE RESEARCH

Research Design: A mixed method research approach was chosen as the research design for the current study. This design matches the current study's aim to examine the Bangladeshi PHFPs' safe food perception and the integration of these understanding into their food purchasing decision making process. This study examines safe food perceptions, strategies to purchase safe food and their information sources along with the relationship of these independent variables to the dependent variable, the PHFP of Bangladesh (Creswell & Clark, 2018). Further, this study will determine how these food perceptions and purchasing strategies vary among the PHFP. Thus, this quantitative part of the study will examine relationships among variables as well as explain trends by answering research questions to construct overall tendency of the response from individuals, and to ascertain the variation of this tendency among the people (Creswell, 2014). The present study investigates and focuses on numerical data in order to ensure objectivity and hence, a questionnaire based survey was used as the data collection method (Creswell, 2014; Earl, 2015).

Participant Recruitment and Sampling Methods

The study sample was primary household food purchasers from the different purchasing places such as supermarket and traditional bazar. At the household level, it is common to find either a formal or informal primary food purchaser who bears the responsibility for choosing "safe" foods. The PHFP relies on their food knowledge and skills to source and procure safe foods. This research aims to explore the safe food factors which help the PHFP during their daily food purchasing decision making process. In the current research, two inclusion criteria were used to screen the target population (Patino & Ferreira, 2018). They are:

i) The food purchaser should be the primary purchaser of a household and,
ii) Be aged 18 years or more.

The study sample was primary household food purchasers from supermarkets and traditional markets in Bangladesh.

Quantitative Study Sample

Quantitative data were collected by using a convenience sampling method for this current research. Considering the time and budget of this particular study, convenience sampling was chosen, because it is the easiest, least time consuming and least expensive method (Bornstein, Jager, & Putnick, 2013). The participants for the quantitative study were recruited by well-trained surveyors along with the researcher through asking individuals to complete the survey prior to entry to the marketplace. If they met the criteria and were happy to assist, the survey was conducted after verbally explaining the material in the information sheet and obtaining written consent that was developed as part of ethical clearance.

Qualitative Study Sampling

The qualitative component of this research consisted of two FGDs with purposively sampled participants from the pool of survey participants. A FGD is a flexible and valuable element of mixed method study design and has wide application in health, behavioural research and social science (Hennink & Leavy, 2014). This current study aimed to identify a wide range of perspectives on the safe food perception and to obtain an in-depth understanding of these perceptions in the PHFP sample along with their strategies, information sources and improvement of food safety in this community (Hennink & Leavy, 2014).

Data Collection

Data were collected from two different locations in Bangladesh, one in Dhaka and another one at Faridpur. Dhaka is the capital city of Bangladesh with a total area of 1463.60 square kilometre. According to the census of 2011, the total population of Dhaka city is approximately 8.9 million and the density is 30,551 per

square kilometre. The economy of urban area of Dhaka is industry based. The literacy rate of this city is 74.6% (Bangladesh Bureau of Statistics, 2013). There are approximately 200 supermarkets in Bangladesh in operation and around 40 of them are located in Dhaka (SM. Ahmed, 2017). Also there are 345 bazaars in this city (Bangladesh Bureau of Statistics, 2013). The survey data was collected in Dhaka city from one supermarket and one traditional bazaar. A supermarket was selected from the Dhanmondi area of Dhaka as it was easily accessible for the researcher, and the traditional bazaar was situated approximately 5 kilometres from the supermarket. The third sampling site was a bazaar in Faridpur. Faridpur is one of the districts of Dhaka division and it is situated 123.8 km north of the Dhaka city. The total population of Faridpur district is approximately 1.9 million and the literacy rate is 49%. The economy of Faridpur district is mainly agriculture based and at present, there are 48 daily bazaars there, but no supermarket (Bangladesh Bureau of Statistics, 2013). Data were collected from one bazaar in Faridpur main city.

Survey

In health research, questionnaires are generally used to obtain primary quantitative data in a valid, reliable and unbiased way from a representative sample of a target population (McColl et al., 2001). Surveys are designed to provide a snapshot of a situation at a specific point in time, and are considered suitable for descriptive studies (Kelley, Clark, Brown, & Sitzia, 2003). In connection with the current study a structured quantitative cross-sectional survey has been used to collect the primary data. The survey comprised of 16 questions to assess demographic information, perception of safe food, purchasing strategies, importance of safe food and information sources of safe food purchasing. The survey used for this research was based on question sets used in several other studies in other countries, as there is limited research about consumer attitude and behaviour towards safe food in Bangladesh (Bruhn & Schutz, 1999; Ergönül, 2013; Gupta, 2009; A. Liu & Niyongira, 2017; Röhr, Lüddecke, Drusch, Müller, & Alvensleben, 2005). Table 3.1 and 3.2 describes the variables.

Table 1: Description of Demographic Variables

Measurements	Measure Description
Age	18 to 60 years and older
Gender	Female, male, others
Education level	Primary, secondary, diploma, college, university (bachelor), university (masters, PhD), others
Occupation level	Professional/technical, sales and services, clerical, market-oriented farmers and fishery worker, skilled manual, unskilled manual, general labour, business/self-employed, armed forces, housewife, not employed, student, others
Income level per month	5,000 BDT to more than 120,000 BDT (Bangladeshi Taka)

Three surveys were conducted by well-trained surveyors along with the researcher in the three different settings. The food purchasers were invited to participate in the survey and completed the survey orally. The surveyors read the consent paper for the participants and after being taken appropriate written consent, they started to ask the questions orally and simultaneously filled up the survey forms. Each survey took 15 to 20 minutes to complete and concluded with the interviewer thanking individual respondents for their participation in this current study. A gift voucher of 1200 BDT (AUD$20) was provided by a raffle draw to the participants of Dhaka city as an incentive, after the completion of the whole survey. A copy of the complete questionnaire is provided in Appendix 2.

Data Analysis

Quantitative Analysis: First, to assess normal distribution of the data, skewness, kurtosis and Shapiro-Wilk statistics were generated. Q-Q plots were also generated and visually inspected. For the majority of the data, assumptions of normality were not supported. Due to the violation of normality assumptions and to ensure consistency, non-parametric tests were conducted to analyze the quantitative results.

Statistical analysis was conducted using the Statistical Package for Social Sciences (SPSS) program, version 26. A Chi-square test was conducted to test for differences between the demographic variables, safe food perceptions and reporting of the foodborne illnesses, perceived declination of safety of certain foods, considering food hazards while food purchasing, information sources and their helpfulness in safe food purchasing strategies - in all locations namely-Dhaka supermarket and traditional bazaar and the Faridpur city bazaar. A frequency analysis was conducted in all study locations to measure the priority of food

purchasing factors and the top 5 factors were ranked according to the percentage of the PHFP who considered these factors 'always' in all study locations. Several Mann-Whitney U tests were conducted to test for differences between males and females for safe food perception level, reporting of the foodborne illnesses, safe food purchasing strategies and consideration of food hazard level while purchasing foods. This particular test compares the medians of the two groups by converting the scores on the continuous variable to ranks across the two groups, and then evaluating whether the ranks for both groups are significantly different and the scores are converted into ranks (Milenovic, 2011). Further, to compare between different education and occupation levels several Kruskal Wallis H tests were performed with the above-mentioned variables. The Kruskal Wallis test is a nonparametric, analogue of a one-way ANOVA test that does not make assumptions about normality. Like most nonparametric tests, it is performed on the ranks of the measurement observations.

The Kruskal Wallis test starts by substituting the rank in the overall data set for each measurement value. The smallest value gets a rank of 1, the second smallest gets a rank of 2 (Hecke, 2012). Lastly, pairwise comparisons were performed using Dunn's procedure with a Bonferroni correction for the multiple comparisons.

Qualitative Analysis: The recorded interview responses were transcribed by the researcher and by analysing the content of the interview transcriptions, data analysis was undertaken. Content analysis consists of a process that first categorizes the data, and then, by summarising the content of categories, themes are created to reach a conceptual explanation (Neuman, 2006; Forman et al., 2008). In the current study, the qualitative analysis was done by systematically reading through the transcripts multiple times and to conceptualise the data, notes were taken for any significant categories that could arise (Broom, 2005). As suggested by Liamputtong (2009), participants response were compared and contrasted to highlight emerging trends and common concepts. Lastly, to bring the patterns of data together, meta-themes were created, and the literature was revisited to tie findings together with conclusions from similar studies (Broom, 2005).

RESULTS AND DISCUSSION

This chapter presents the findings of the research. First, the demographic characteristics of participants in all three study locations are presented. This is followed by a summary of perceptions of safe food and reporting of food borne illnesses among primary household food purchasers (PHFP). Next, descriptive statistics are presented on the priority of purchasing strategies of safe food, consideration of safe food reduction and information sources for safe food purchasing strategies. Inferential statistical analyses are then presented on the associations between socio-demographic variables and measures of safe food perception, reporting of food borne illnesses, consideration of food hazards, information sources and purchasing strategies of food findings. In the last section of this chapter, the qualitative findings of the study are overviewed and summarized in tables.

Demographic Profile

The study was conducted in two different geographic locations: Dhaka, the capital city of Bangladesh and Faridpur City, a regional city outside Dhaka. In total, there were three data collection sites: a supermarket and a traditional market Bazar at Dhaka and a traditional market bazar at Faridpur City. The demographic information of the PHFP is summarized in Table 4.1(page 60). In total, 450 PHFPs participated in the study across all three areas with ages ranging from 18 to more than 60 years with the largest portions being 30 to less than 40 years (33.6%) and 40 to less than 50 years (33.3%). 44% had at least a university bachelor's degree level of education. Of the total participants from the three locations, almost half (49.8%) reported employment in a professional/technical job, were a business owner or self-employed. In addition, 33.3% reported that their monthly income was less than 50,000 BDT (Bangladeshi taka) ($869.27 AUD) and 31.6% reported more than 50,000 BDT but less than 100,000 BDT ($1700.80 AUD). Whereas, 21.8% reported more than 100,000 BDT as their monthly income.

To compare the difference in these demographic variables among PHFP surveyed at the supermarket at Dhaka, traditional bazar at Dhaka and Faridpur city bazar, Chi-square tests were performed, as less than 20% cells have expected count less than 5. The results show statistically significant differences ($p < 0.01$) among all three locations for age, education, occupation and income level. The highest percentage of the PHFP in the supermarket were aged between 30 to less than 40 years (40%), traditional bazar was between 40 to less than 50 years (40%) and Faridpur City bazar were between 30 to less than 50 years (30.7%)

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Table 2: Demographic characteristics of PHFP at 3 different study locations

	Total	Supermarket Dhaka	Traditional bazar Dhaka	Faridpur city bazar	χ^2 P value
	n (%)	n (%)	n (%)	n (%)	
Age in years (N=450)					χ^2 = 28.3 p<0.01**
18 - less than 20	1(0.2)	0	0	1(0.7)	
20 - less than 30	73(16.2)	13(8.7)	27(18)	33(22)	
30 - less than 40	151(33.6)	60(40)	45(30)	46(30.7)	
40 - less than 50	150(33.3)	44(29.3)	60(40)	46(30.7)	
50 - less than 60	57(12.7)	27(18)	9(6)	21(14)	
60 years and older	18(4)	6(4)	9(6)	3(2)	
Education (N=443)					χ^2 =63.3 p<0.001***
Primary & secondary (1-10)	50(11.3)	0	24(16.3)	26(17.8)	
College & Diploma	97(21.9)	22(14.7)	27(18.4)	48(32.9)	
University (Bachelor)	195(44)	78(52)	57(38.8)	60(41.1)	
University (Masters, PhD)	101(22.8)	50(33.3)	39(26.5)	12(8.2)	
Occupation (N=450)					χ^2 =15.7 p<0.01**
Type 1	224(49.8)	80(53.30)	57(38)	87(58)	
Type 2	103(22.9)	30 (20)	48(32)	25(16.7)	
Type 3	123(27.3)	40(26.7)	45(30)	38(25.3)	
Income (N=450)					χ^2 =177.1 p<0.001***
5,000 to less than 20,000	60(13.3)	0	36(24)	24(16)	
20,000 to less than 50,000	150(33.3)	15(10)	42(28)	93(62)	
50,000 to less than 100,000	142(31.6)	67(44.7)	45(30)	30(20)	
more than 100,000	98(21.8)	68(45.3)	27(18)	3(2)	

p <0.001***, p <0.01**

The education level was the most statistically significantly different between the market types (<0.001). The percentage of University Bachelors were the highest (52%) and college /diploma was the lowest (14.7%) in the Dhaka supermarket compared to the Dhaka traditional bazar and Faridpur City bazar. In the Dhaka traditional bazar, 38.8% were University Bachelors and the lowest percentages (16.3%) of the PHFP were from primary/secondary (1-10) level. Whereas, in Faridpur city bazar, 41.1% were University Bachelors and University Masters or PhD were the lowest percentages (8.2%).

Occupations were categorised into three groups (Type 1, 2, 3), where type 1 represents professional/technical and business/ self-employed jobs; type 2 as sales and service, clerical, skilled manual and armed forces; and type 3 as market oriented farmer and fishery worker, unskilled manual, general labour, not employed, housewife and student. The occupation types also were statistically significantly different (<0.01). At Faridpur city bazar 58% of the PHFP had type 1 jobs and the lowest percentages (16.7%) were doing type 2 jobs compared to supermarket and traditional bazar, Dhaka. Whereas, 53.3% in supermarket and 38% in traditional bazar, Dhaka had type 1 jobs.

The highest percentage (45.3%) of the PHFP at supermarket, Dhaka reported that they had a monthly income level more than 100,000 BDT ($ 1,738.54 AUD) and the lowest percentage (10%) reported between 20,000 BDT ($347.71 AUD) to less than 50,000 BDT ($869.27 AUD) per month and this was statistically significant at p<0.001. 30% of PHFP from traditional bazar had an income range from 50,000 ($869.27 AUD) to less than 100,000 BDT ($ 1,738.54 AUD); whereas, the highest percentage (62%) of PHFP from Faridpur City bazaar reported their income range between 20,000 BDT ($347.71 AUD) to less than 50,000 BDT ($869.27 AUD).

Quantitative Findings

Perception of safe food and reporting of foodborne illness among PHFP

The safe food perception of the PHFP was measured in section B1 of the questionnaire. Participants were asked to indicate their perception of safe food in Bangladesh considering different food hazards (e.g. biological, chemical) on a Likert scale from (1) 'Strongly disagree' to (5) 'Strongly agree'. A copy of the complete questionnaire is provided in Appendix 2. To check the normal distribution of safe food perception, Shapiro-Wilk tests ($p>0.05$), and visual inspection of histograms were performed. These indicated that the perceptions were not normally distributed. The Cronbach's alpha of safe food perception scale was above 0.7 (.84) indicating good internal consistency (Gliem & Gliem, 2003).

The value of median and range of safe food perceptions are presented in Table 4.2. 'Usage of chemicals in food such as non-food grade food additives or food colour'; 'contamination of food by pesticides'; 'contamination of fish and fruits by formalin'; 'Contamination of foods by germs'; and contamination of fruits by using ripening agents such as calcium carbide – all the variables of safe food perception were combined and generated the composite variable - 'overall perception of safe food in PHFP' by transforming and computing the variables through SPSS. Therefore, the combined result of 3 study locations revealed an overall score for the perception of safe food. The median and range of overall safe food perception is presented in Table 3.

Table 3: Safe food perception in all 3 study locations.

Perception of safe food in Bangladesh	Supermarket n=150	Traditional bazar Dhaka n= 150	Faridpur city bazar n=150	All areas N=450
	Median (min, max)	Median (min, max)	Median (min, max)	Median (min, max)
Usage of chemicals in food such as non-food grade food additives or food colour is a food safety problem in Bangladesh	5 (4,5)	4(3,5)	4 (4, 5)	4 (3, 5)
Contamination of food by pesticides is a food safety problem in Bangladesh	5 (3,5)	4(2,5)	4 (3, 5)	4 (2, 5)
Contamination of fish and fruits by formalin is a food safety problem in Bangladesh	5 (3,5)	4.5 (2, 5)	4 (2, 5)	4 (2, 5)
Contamination of foods by germs is a food safety problem in Bangladesh	4 (2,5)	4 (2,5)	4 (3, 5)	4 (2, 5)
Contamination of fruits by using ripening agents such as calcium carbide is a food safety problem in Bangladesh	4 (2, 5)	4 (2, 5)	4 (3, 5)	4 (2, 5)
Overall perception of safe food in PHFP	4.6 (3.2,5)	4.1 (2.4,5)	4 (3.2,5)	4.4(2.4,5)

Reporting of Foodborne Illnesses

The reporting of foodborne illnesses was measured in B2 of the questionnaire. Participants were asked to indicate their frequency of suffering from foodborne illnesses on a scale from (1) 'Never' to (5) 'Very often'. Normality of the distribution of frequency of foodborne illnesses reported was tested using Shapiro-Wilk tests (P>0.05), and visual inspection of histograms. These indicated that they were not normally distributed. Cronbach's alpha of the reporting of foodborne illnesses scale was above 0.7 (.85) indicating good internal consistency.

The median and range of the frequency of foodborne illnesses reported are presented in Table 4.3. The table shows the symptoms of foodborne illnesses that the PHFP suffered from 'never' to 'very often' in their lifetime. All the foodborne illnesses variables were transformed and computed in SPSS with the composite variable 'overall reporting of foodborne illness' generated. Median and range of the frequency of overall foodborne illnesses reporting is presented in Table 4.

Table 4: The reporting of foodborne illnesses

Symptoms of food borne illnesses	Supermarket Dhaka n= 150	Traditional bazar Dhaka n= 150	Faridpur city bazar n= 150	All area N=450
	Median (min, max)	Median (min, max)	Median (min, max)	Median (min, max)
Have you ever suffered from food borne originated stomach-ache	2 (1,3)	2 (1,4)	2 (1,4)	2 (1,4)
Have you ever suffered from food borne originated diarrhoea	2 (1,3)	2 (2,4)	2 (2,4)	2 (1, 4)
Have you ever suffered from food borne originated nausea /vomiting	2 (1,3)	2 (2,3)	2 (1,4)	2 (1, 4)
Overall reporting of foodborne illness	2(1,3)	2(1.67,3.67)	2(1.33,4)	2(1,4)

Safe Food Purchasing Strategies

Safe food purchasing strategies were measured in section C of the questionnaire. In this section, the PHFP were asked to indicate the consideration of food purchasing factors in general; followed by asking the purchasing factors of 3 specific food types: fish, fruits and vegetables, and packaged food. They were then asked about their perceptions on the decline of food safety in Bangladesh for 9 food category items including fish, fruits, eggs and milk. The details are presented in the following sections.

Priority of food purchasing factors in general

The safe food purchasing factors were measured in C1 section of the questionnaire. Participants were asked to indicate their food purchasing factors used including aspects such as appearance, freshness, colour and expiry date, on a scale from (1) 'Never' to (5) 'Always'. In total, 12 factors were measured. Shapiro-Wilk tests were performed, indicating that the factors were not normally distributed and the Cronbach's alpha of food purchasing factors scale was above 0.7 (.85) indicating good internal consistency. A frequency analysis was conducted in all study locations to measure the priority of food purchasing factors. Among 150 participants, 92% in the Dhaka supermarket considered freshness was 'always' the most important factor, followed by colour (74%) and expiry date (71.3). In contrast, for the Dhaka traditional bazar (78%) and Faridpur city bazar (90%), the first priority for purchasing was price. Among 12 factors, the top 5 ranking are presented in table 5.

Table 5: Top five priority of food purchasing factors in all study areas

N=450	Supermarket	Dhaka[a]	Traditional	Bazar Dhaka[b]	Faridpur city	Bazar[c]
Food Purchasing Factors	n (%)		n (%)		n (%)	
Appearance [abc]		98 (65.3)[5]		102 (68)[4]		84 (56)[2]
Freshness [abc]		138 (92)[1]		111 (74)[2]		84 (56)[2]
Taste [bc]		88 (58.7)		78 (52)		84 (56)[2]
Colour [abc]		111 (74)[2]		105 (70)[3]		81 (54)[3]
Expiry date [abc]		107 (71.3)[3]		87 (58)[5]		72 (48)[4]
Seasonality[c]		68 (45.3)		66 (44)		66 (44)[5]
Origin of the product [a]		102 (68)[4]		45 (30)		45 (30)
Price [bc]		81 (54)		117 (78)[1]		135 (90)[1]

Note: a, b, c represents three different purchasing places;
1, 2, 3… represents food purchasing factor ranking. Table presents the percentage of 'always'

Priority of purchasing determinants of fish, fruits and vegetables, packaged foods Fish, fruit and vegetables and packaged food purchasing determinants were measured in C2, C3 and C4 sections of the questionnaire. Participants were asked to indicate their purchasing determinants of these specific 3 food types, on a scale from (1) 'Never' to (5) 'Always'. Shapiro-Wilk tests were performed, indicating that the determinants were not normally distributed.

The frequency analysis of fish, fruit and vegetables, packaged food was conducted in all study locations to measure the priority of purchasing factors of these 3 food items More than 90% respondents 'always' considered 'freshness' as the most important purchasing factor for fish, fruits and vegetables at supermarket. Similarly, 80% respondents in the traditional bazar Dhaka reported that they 'always' considered 'freshness' while purchasing fish, fruits and vegetables. The top five food purchasing factors for fish, fruits and vegetables and packaged food are displayed in the Table 6 and 7.

Table 6: Ranking of purchasing factors of 3 food items in supermarket Dhaka

n=150 Food purchasing factors	Fish [a] n (%)	Fruit and vegetables [b] n (%)	Packaged food [c] n (%)
Appearance [ab]	98 (65.3)[4]	98 (65.3)[5]	
Freshness [ab]	138 (92)[1]	141 (94)[1]	
Taste		102 (68)[4]	
Colour [ab]	123 (82)[2]	117 (78)[2]	
Packaging [c]			50 (33.3)[4]
Labelling of nutritional advice [c]			41 (27.3)[5]
Expiry date [c]			108 (72)[1]
Origin of the product [abc]	102 (68)[3]	105 (70)[3]	107 (71.3)[2]
Place of purchase [c]		68 (45.3)	71 (47.3)[3]

Note: a, b, c represents three different food items;
1, 2, 3… represents food purchasing factor ranking. Table presents the percentage of 'always'

Table 7: Ranking of purchasing factors of 3 food items in traditional bazar Dhaka

n=150 Food purchasing factors	Fish [a] n (%)	Fruit and vegetables [b] n (%)	Packaged food [c] n (%)
Appearance [ab]	111 (74)[2]	110 (73.3)[2]	
Freshness [ab]	120 (80)[1]	120 (80)[1]	
Taste [b]		87 (58)[4]	
Colour [ab]	108 (72)[3]	105 (70)[3]	
Seasonality [b]		60 (40)[5]	
Packaging [c]			54 (36)[4]
Labelling of nutritional advice [c]			36 (24)[5]
Expiry date [c]			84 (56)[1]
Origin of the product [ac]	60 (40)[4]	54 (36)	66 (44)[2]
Place of purchase [c]		48 (32)	57 (38)[3]

Note: a, b, c represents three different food items;
1, 2, 3… represents food purchasing factor ranking. Table presents the percentage of 'always'

At Faridpur City bazar both freshness and appearance were reported as equal highest mean score for fish, fruits and vegetables (Table 8). Seasonality as a purchasing factor ranked 4 and 5 for fruits and vegetables in Faridpur city bazaar (M=3.8, SD= 1.2) and traditional bazar (M=3.64, SD=1.4) respectively (Table 7 and 8). However, expiry date was the top priority for the purchasing of packaged food in all 3 study locations (Table 6, 7 and 8).

Table 8: Ranking of purchasing factors of 3 food items in Faridpur city bazaar

n =150	Fish [a]	Fruit and vegetables [b]	Packaged food [c]
Food purchasing factors	n (%)	n (%)	n (%)
Appearance [ab]	102 (68)[1]	90 (60)[1]	
Freshness [ab]	102 (68)[1]	90(60)[1]	
Taste [b]		84 (56)[3]	
Colour [ab]	99 (66)[2]	87 (58)[2]	
Seasonality [b]		63 (42)[4]	
Packaging [c]			42 (28)[3]
Labelling of nutritional advice			36 (24)[4]
Expiry date [c]			84 (56)[1]
Origin of the product [abc]	66 (44)[3]	45 (30)[5]	45 (30)[2]
Place of purchase [c]		36 (24)	36 (24)[4]
Convenience of shopping [c]			6 (4)[5]

Note: a, b, c represents three different food items;
1, 2, 3… represents food purchasing factor ranking.
Table presents the percentage of 'always'

Perception of Decline in Safety of Food Types

The PHFP were asked to indicate whether they thought there had been any decline in the safety of 9 food types in the last five years, on a six-point scale from (1) 'Definitely not' to (6) 'Definitely'. To reduce the scale during data analysis, the 9 food items were recorded, and new value labels were added, where 'Definitely not', 'Very probably not' and 'Probably not' were labelled as 'No' and 'Probably', 'Very probably' and 'Definitely' as 'Yes'. Next, several Chi square tests were performed to measure the differences of reduction in safety of 9 food items in all study locations (Table 4.8). The Cronbach's alpha of reduction in safety of food scale was above 0.7 (.9) indicating good internal consistency. In all 3 study locations less than 50% of PHFPs perceived any reduction in safety of the 9 food items (Table 4.8). However, when focussing on the perception of decline in safety of fish, fruits, red meat, bread & bakery and packaged food, the Chi square results identify significant differences among the three study locations ($p < 0.001$). 62% PHFPs at Faridpur City bazar perceived 'probably' or 'very probably' or 'definitely' reduction in safety of fish, whereas, only 34% at supermarket and 28% at Dakar traditional bazar perceived any reduction of fish safety. Similarly, at Faridpur bazar 80% perceived decline in safety of packaged food, but only 24% at supermarket and 36% at Dakar traditional bazar perceived so. There were no statistically significant differences found for decline in safety for egg, milk and dairy products across the study locations. Table 4.8 shows the perceived reduction in safety of 9 food items across all 3 study locations.

Table 9: Comparison of the perceived decline in safety of food types across the study locations

Food type	All area N=450	Supermarket Dhaka n (%)	Traditional Bazar Dhaka n (%)	Faridpur Bazar n (%)	χ^2	p value
Fish	186 (41.3%)	51 (34%)	42 (28%)	93 (62%)	χ^2=40.7	000***
Fruits	189 (42%)	54 (36%)	45 (30%)	90 (60%)	χ^2=30.03	000***
Raw vegetables	150 (33.3%)	45 (30%)	39 (26%)	66 (44%)	χ^2=12	0.002**
Red meat	105 (23.3%)	18 (12%)	30 (20%)	57 (38%)	χ^2=29.7	000***
Egg	141 (31.3%)	39 (26%)	45 (30%)	57 (38%)	χ^2=5.2	0.07
Milk	210 (47%)	66 (44.9%)	69 (46%)	75 (50%)	χ^2=0.86	0.65
Dairy products	198 (44%)	60 (40%)	63 (42%)	75 (50%)	χ^2=3.4	0.18
Bread & bakery	189 (42%)	36 (24%)	54 (36%)	99 (66%)	χ^2=57.6	000***
Packaged food	210 (46.7%)	36 (24%)	54 (36%)	120(80%)	χ^2=104.7	000`***

p<0.001***, p<0.01** (note: Table presents the percentages of 'Yes')

Importance of safe food

Importance of safe food from consumer was questioned in the section D of the questionnaire. The participants were asked to indicate their consideration of food hazards while purchasing food, on a scale from (1) 'Never' to (5) 'Always'. Also, they were asked about purchasing frequency across different shopping locations such as supermarket, street market or bazar. Shapiro-Wilk tests were performed and

indicated that the food hazards were not normally distributed and the Cronbach's alpha of importance of safe food scale was above 0.7 (.87) indicating good internal consistency.

Consideration of food hazards while purchasing food

Median and range of consideration of food hazards in all study locations are presented in Table 10.

Table 10: Consideration of Food Hazards in All 3 Study Locations while food purchasing

Food hazards	All Study Areas N=450	Supermarket Dhaka n =150	Traditional Bazar Dhaka n =150	Faridpur city Bazar n =150
	Median (min,max)	Median (min,max)	Median (min,max)	Median (min,max)
Bacterial contamination	3 (1,5)	3 (2,5)	3 (1,5)	3 (1,5)
Pesticide residues in food	3 (1,5)	3 (1,5)	3 (1,5)	3.5 (1,5)
Heavy metals in food	1 (1,5)	1 (1,5)	1 (1,5)	1 (1,5)
Food spoilage	2 (1,5)	3 (1,5)	2 (1,5)	1 (1,5)

Transforming and computing the above food hazard variables, the composite variable 'overall consideration of food hazard' was generated and compared to the other study locations in consideration of food hazards.

Purchasing frequency in different shopping places

PHFP from all study locations were asked to indicate their purchasing frequency at different shopping places such as supermarket, traditional bazar and street market, on a scale from (1) '4 or more times weekly' to (5) 'Never'. Descriptive frequency analysis was conducted to measure the percentages of PHFP for purchasing frequency at different shopping places. The highest percentage of (42%) PHFP from supermarket Dhaka reported that their purchasing frequency from supermarket was 2-3 times weekly and also found that the lowest percentage of PHFP from supermarket purchase food very frequently (4 or more times weekly) from traditional bazar Dhaka (2%) and street market (4%) (Table 11).

Table 11: Purchasing frequency in following places (study location: supermarket Dhaka)

Table 4.10: Purchasing frequency in following places **(study location: supermarket Dhaka)**

N=150 Purchasing frequency	Supermarket n (%)	Traditional bazar n (%)	Street market n (%)
4 or more times weekly	21 (14%)	3 (2%)	6 (4%)
2-3 times weekly	63 (42%)	23 (15.3%)	3 (2%)
once weekly	39 (26%)	33 (22%)	52 (34.7%)
1-2 times monthly	27 (18%)	64 (42.7%)	30 (20%)
never	0	27 (18%)	59 (39.3%)

The purchasing frequency of PHFP from traditional bazar Dhaka shows that most purchase food from traditional bazar (70%) and street market (34%) once weekly; but a higher percentage (42%) of PHFP from traditional bazar reported that they never purchase food from supermarket (Table 12).

Table 12: Purchasing frequency in following places (study location: Traditional bazar Dhaka)

Purchasing frequency	Traditional bazar n (%)	Supermarket n (%)	Street market n (%)
4 or more times weekly	15 (10%)	0	0
2-3 times weekly	30 (20%)	3 (2%)	45 (30%)
once weekly	105 (70%)	36 (24%)	51 (34%)
1-2 times monthly	0	48 (32%)	12 (8%)
never	0	63 (42%)	42 (28%)

In Faridpur City there was no supermarket to purchase food and, therefore, the data from bazar and street market were included in the study. Most of the PHFP (54%) from Faridpur City bazar reported that they purchase food from bazar 2-3 times weekly. Further, 34% reported that they never purchase food from street market (Table 13).

Table 13: Purchasing frequency in following places (study location: Faridpur City bazar)

N=150 Purchasing frequency	Supermarket n (%)	Traditional bazar n (%)	Street market n (%)
4 or more times weekly	-	30 (20%)	3 (2%)
2-3 times weekly	-	81 (54%)	42 (28%)
once weekly	-	30 (20%)	45 (30%)
1-2 times monthly	-	9 (6%)	9 (6%)
never	-	0	51 (34%)

Information sources of safe food purchasing strategies

Where the PHFP source information on safe food purchasing strategies and their usefulness was measured in section E of the questionnaire. The PHFP were asked to indicate their frequency in seeking information about the strategies to purchase safe food from certain media such as newspaper, TV/radio and government authority, on a scale from (1) 'Never' to (5)'Always'. Additionally, the PHFP also indicated the usefulness of these sources, on a scale from (1) 'Extremely helpful' to (5) 'Not at all helpful'. Shapiro-Wilk tests indicated that the items were not normally distributed and the Cronbach's alpha of information source of safe food purchasing strategies scale was above 0.7 indicating acceptable internal consistency.

Of the total 450 participants in all study locations, 36.7% indicated that they often get information of safe food purchasing strategies from family and friends. Whereas, 94.7% and 48.7% indicated they never get information from a university or government authority respectively (Table 14).

Table 14: Information Sources of Safe Food Purchasing strategies

Media	Never	Rarely	Sometimes	Often	Always
N=450	n (%)	n (%)	n (%)	n (%)	n (%)
Newspaper	60 (13.3)	60 (13.3)	195(43.3)	90 (20)	45 (10)
TV/Radio	39 (8.7)	78 (17.3)	192 (42.7)	96 (21.3)	45 (10)
Government authority	219 (48.7)	128 (28.4)	88 (19.6)	12 (2.7)	3 (0.7)
Family & friends	12 (2.7)	57 (12.7)	101 (22.4)	169 (36.7)	111 (24.7)
Scientist/nutritionist	267 (59.3)	76 (16.9)	92 (20.4)	12 (2.7)	3 (0.7)
University	426 (94.7)	12 (2.7)	9 (2)	3 (0.7)	-

Of total 450 participants 38.7% indicated family and friends as a helpful information source for safe food purchasing strategies. Whereas, 95.3% and 71.8% mentioned university and government authority as not at all helpful sources respectively (Table 15).

Table 15: Helpfulness of the Information Sources in Safe Food Purchasing Strategies

Media N=450	Extremely Helpful n (%)	Very Helpful n (%)	Somewhat Helpful n (%)	Slightly Helpful n (%)	Not at all Helpful n (%)
Newspaper	18 (4)	38 (8.4)	223 (49.6)	75 (16.7)	96 (21.3)
TV/Radio	24 (5.3)	44 (9.8)	220 (48.9)	84 (18.7)	78 (17.3)
Government authority	15 (3.3)	9 (2)	27 (6)	76 (16.9)	323 (71.8)
Family & friends	82 (18.2)	174 (38.7)	128 (28.4)	42 (9.3)	24 (5.3)
Scientist/nutritionist	9 (2)	26 (5.8)	75 (16.7)	58 (12.9)	282 (62.7)
University	3 (0.7)	3 (0.7)	12 (2.7)	3 (0.7)	429 (95.3)

Overall comparison with the demographic characteristics

The following sections compare the overall safe food perception, reporting of food borne illnesses, consideration of food hazards, safe food purchasing strategies and information sources with the socio-demographic characteristics including gender, education, occupation and location.

Safe food perception

To investigate whether demographic characteristics of gender, education and occupation were associated with overall safe food perception, Mann-Whitney U test and Kruskal Wallis H tests were performed. First, a Mann-Whitney U test was performed to determine if there were differences in 'overall safe food perception in PHFP' between females and males. The result shows higher mean rank score for female (242.2) compared to male (204.8) and this was statistically significant ($Z= -3.134$, $p <0.01$).

Second, a Kruskal Wallis H test was performed to determine if there were differences in 'overall perception of safe food in PHFP' across education levels. The mean rank of overall safe food perception was statistically significant across education levels ($\chi2$ (2) =52.91, $p <0.001$).

Subsequently, pairwise comparisons were performed using Dunn's procedure with a Bonferroni correction for multiple comparisons. Adjusted p-values are presented, and the significance level set at 0.05 ($p < 0.05$). The post hoc analysis revealed statistically significant differences between primary/secondary (111.6) and college/diploma (200.7), or primary/ secondary and university (Bachelor) (244.9) or primary/secondary and university (Masters, PhD) (246.9) ($p <0.001$).

Also, statistically significant differences between college/diploma and university (Masters, PhD) ($p =0.025$). But no statistically significant difference between college/diploma and university (Bachelor) ($p=0.056$) or university (Bachelor) and university (Masters, PhD) ($p=1.000$). Third, a Kruskal Wallis H test was performed to determine if there were differences across occupation types with 'overall safe food

perception'. The mean rank of overall safe food perception was statistically significant between occupation types ($\chi2(2) = 32.13$, $p < 0.001$).

Subsequently, pairwise comparisons were performed and the post hoc analysis revealed statistically significant difference between type 1 (258.16) and type 2 (187.09) ($p<0.001$); type 1 and type 3 (193.54) occupation ($p<0.001$). However, no statistically significant difference was identified between type 2 and type 3 occupation ($p=1.000$).

Last, nonparametric Kruskal Wallis H test was conducted to test for differences in overall as well as all the variables of safe food perception among the PHFP of the three study locations. For the Kruskal Wallis H test, the mean rank is mentioned as the distributions for all three areas were not equal. The mean rank of safe food perceptions, 'Usage of chemicals in food such as non-food grade food additives or food colour' ($\chi2 = 39.98$, $p = <0.001$); 'Contamination of food by pesticides' ($\chi2 = 28.06$, $p < 0.001$); 'Contamination of fish and fruits by formalin' ($\chi2 = 11.42$, $p < 0.01$) were statistically significantly different between study locations. No statistically significantly difference between the study locations was found for the items related to perception of 'Contamination of foods by germs' and 'Contamination of fruits by using ripening agents such as calcium carbide'.

Table 16: Comparison of safe food perception between the study areas

Perception of safe food in Bangladesh	Supermarket N=150	Traditional bazar Dhaka N = 150	Faridpur city bazar N=150	χ2	p value
	Median (min, max)	Median (min, max)	Median (min, max)		
Usage of chemicals in food such as non-food grade food additives or food colour is a food safety problem in Bangladesh	5 (4,5) 270.47	4(3,5) 212.38	4 (4, 5) 190.08	39.98	000***
Contamination of food by pesticides is a food safety problem in Bangladesh	5 (3,5) 260.95	4(2,5) 225.60	4 (3, 5) 189.95	28.06	000***
Contamination of fish and fruits by formalin is a food safety problem in Bangladesh	5 (3,5) 241.88	4.5 (2, 5) 234.82	4 (2, 5) 199.80	11.42	0.0`08**
Contamination of foods by germs is a food safety problem in Bangladesh	4 (2,5) 237.38	4 (2,5) 212.24	4 (3, 5) 226.88	3.42	0.181
Contamination of fruits by using ripening agents such as calcium carbide is a food safety problem in Bangladesh	4 (2, 5) 220.84	4 (2, 5) 215.16	4 (3, 5) 240.50	3.56	0.168
Overall perception of safe food in PHFP	4.6 (3.2,5) 240.76	4.1 (2.4,5) 218.97	4 (3.2,5) 212.61	4.04	0.132

P<0.001***, p<0.01**

Foodborne illness reporting

A Mann-Whitney U test was performed to determine if there were differences in 'overall foodborne illness reporting' between females and males. The result shows a higher mean rank score for males (242.8) compared with females (208.7) and this difference is statistically significant ($Z = -3.069$, $p < 0.01$).

Second, a Kruskal Wallis H test was performed to determine if there were differences between education levels in 'overall reporting of foodborne illnesses. The mean rank of 'overall reporting of foodborne illnesses' was statistically significant between education levels ($\chi2 = 11.09$, $p < 0.0$).

CONCLUSION

This research examined the safe food perception of the PHFP (primary household food purchaser) and integration of this understanding into their food purchasing decision making process in Bangladesh. The results show the PHFP have the highest concern about the usage of chemicals in food. It has found some socio-demographic variations such as women have more food safety concern than men, higher educated

people and people who purchase food from supermarket show more awareness of safe food than others. The research has also revealed that compared to chemicals there was a lower perception level of microbiological food hazards. Freshness was considered as an important attribute to purchase safe food and in addition, the PHFP considered expiry date, appearance, taste, colour, seasonality, and origin of the product as features to guide safe food purchasing. However, in some places such as the Dhaka traditional bazar and Faridpur bazar, price was an important consideration while purchasing safe food. Whether supermarket or bazar, most of the PHFP agreed a preference in choosing the place of purchase that they trust. Further, the PHFP reported to change their food consumption habits if they perceive any food is risky. More than half (50%) of the PHFP reported that safe food has not been decreased in the last five years in Bangladesh. In terms of safe food information sources, friends and family members play an important role in this regard.

In present study, the mixed method approach highlighted the importance of the Bangladeshi PHFPs' safe food perception and the integration of these understandings into their food purchasing decision making process. The quantitative component of the study analyzed how these tendencies of safe food perception and purchasing strategies varies among the PHFP. Furthermore, qualitative FGDs revealed the complex and in depth understanding of this key concept of PHFPs' personal experiences. Thus, the findings presented in this study enhance our understanding of the safe food perception, strategies to purchase safe food and their information sources along with the relationship of socio-demographic factors of the PHFP of Bangladesh.

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