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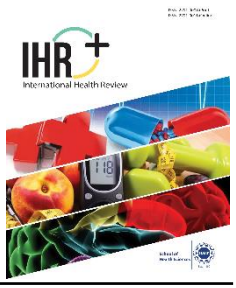

Title:	**Food Safety Knowledge, Hygiene Practices, and Food Preparation and Storage Behaviors among Domestic Food Handlers**
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Food Safety Knowledge, Hygiene Practices, and Food Preparation and Storage Behaviors among Domestic Food Handlers

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ABSTRACT

Food safety is an important component of public health. The World Health Organization (WHO) states that access to safe and nutritious food is essential for the overall health and well-being of an individual. Over 200 diseases, ranging from diarrhea to cancer, are caused by the consumption of food contaminated with harmful bacteria, viruses, parasites, and chemical substances. Unsafe practices within household and commercial food environments can contribute to foodborne illness. The current study focused on assessing the knowledge of food safety, hygiene preparation, and storage practices among domestic food handlers. A cross-sectional study was conducted with 116 adults aged 19-65 years. A convenient sampling technique was used to collect the sample from Lahore, Pakistan. Data was collected using a structured questionnaire that covered five domains of food safety: (I) demographic profile, (II) food safety knowledge, (III) personal hygiene practices, (IV) food purchasing practices, and (V) food preparation and storage practices. Data analysis was carried out using the IBM SPSS software version 25. Most of the participants demonstrated basic knowledge of foodborne illnesses and the importance of hand hygiene. However, a lack of awareness was identified regarding refrigeration, storage temperatures, and checking food labels and expiration dates. Cross-contamination was observed as many respondents use the same cutting boards and utensils for raw and cooked foods. There was also a lack of understanding regarding the ideal meat storage and temperatures. Domestic food handlers possessed knowledge about foodborne illnesses, yet there are gaps in storage practices, contamination prevention, and label checking. Improving food safety education and emphasizing personal hygiene can effectively mitigate the risk of foodborne illnesses.

Keywords: foodborne illnesses, food handling, food safety practices, food safety knowledge, food safety

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1. INTRODUCTION

According to the World Health Organization (WHO), 1.8 million children die yearly from diarrheal sickness; a greater percentage of this illness is brought on by eating contaminated food and drinking adulterated water [1]. Children and older individuals are more susceptible to foodborne illnesses due to a weaker immune system, poor nutritional status, and limited control over meal preparation [2]. Many consumers generally associate foodborne illnesses with eating outside the home, while research suggests that eating homemade food without proper food safety also triggers food poisoning and foodborne illnesses [3]. WHO has identified five causes that contribute to foodborne illnesses: inappropriate cooking methods, maladjustment of temperature during storage, lack of cleanliness and absence of disinfection by food controllers, cross-contamination between raw and fresh food, as well as obtaining food from unsafe sources [4].

Food Safety and Inspection Services recommends proper hand washing before cooking food. It is also advised to keep raw and cooked food separate and maintain clean food preparation and handling areas to avoid cross-contamination. Proper food storage, cooking at the right temperature, and isolating raw meats are essential steps that need to be followed [5]. Food purchasing is also an important factor to minimize the risk of foodborne illnesses. An excellent quality of food supply permits consumers to maintain their well-being, protect themselves against health hazards, and ultimately help in managing their health [6]. A study conducted at the University of Agriculture, Peshawar, Pakistan, showed that females had better food safety practices and knowledge than males [7]. A study conducted on the rural community of Lahore, Pakistan, showed that knowledge among people regarding health hazards due to unhygienic food, unsafe food practices, and food consumption was very poor [8]. A study conducted in Lahore, Pakistan, also found that most household women had a negative attitude towards food safety and demonstrated unhygienic food handling methods. There was a significant disparity in education, KAP scores, as well as household women's attitudes and practices [9]. Lack of food safety practices and consumption of contaminated food are tied directly to foodborne diseases. Thus, it is crucial to improve food safety standards in order to reduce the spread of foodborne diseases [10]. Furthermore, food safety knowledge has a significant impact on the food safety attitudes of food handlers. Enhancing the food safety education of

food handlers is crucial to promote effective food safety measures and reduce the incidence of foodborne diseases [11].

1.1. Objectives

The current study aimed to address the following research objectives:

- To assess the knowledge of food safety practices among domestic food handlers
- To evaluate the food purchasing, food preparation, food storage, and personal hygiene practices of domestic food handlers in households

2. METHODOLOGY

The methodology section outlines the research design and methods used in this study.

2.1. Study Design and Setting

This cross-sectional study was carried out in Lahore, Pakistan. Data was collected from domestic food handlers residing in selected urban and peri-urban localities of Lahore, including Tajpura, Wapda town, and Johar town.

2.2. Sample Size And Technique

The sample size was calculated using the formula $n= Z^2\ 1-\alpha/2*p*(1-p)/d^2 = 116$ [12]. A convenient sampling technique was used. Eligible participants were adults aged between 19 and 65 years, primarily responsible for food preparation at home. Industrialized or commercial food handlers were excluded from this study.

2.3. Data Collection

Data was collected using a structured questionnaire adapted from previously published research [12, 13]. The original questionnaires were validated and specifically designed to assess the knowledge, attitudes, and practices regarding food safety.

2.4. Data Analysis

Data analysis was done through IBM SPSS version 25. Descriptive statistics were presented in the as frequencies and percentages. The Pearson chi-squared test was used to identify the association between food safety knowledge with age, gender, and education.

3. RESULTS

Table 1. Age Distribution of the Study Population

Age Range	Frequency (n)	Percentage (%)
19-34	69	59.5
35-59	37	31.9
50-65	10	8.6
Total	116	100.0

Table 1 shows that the minimum age of the participants was 19 years, and the maximum was 65 years. The majority of participants (59.5%) belonged to the age group of 19-34.

Table 2. Foodborne Illnesses and Food Safety Knowledge among the Study Population

Questions	Variables	Frequency	Percentage
Have you heard about foodborne illnesses?	Yes	92	79.3
	No	24	20.7
What are the symptoms of foodborne illnesses?	Diarrhea	9	7.8
	Vomiting	6	5.2
	Abdominal Pain	6	5.2
	All of These	87	75.0
	Don't Know	8	6.9
How can you minimize the risk of food contamination?	Putting food in two separate containers	69	59.5
	Using the same utensils for different foods	15	12.9
	Put cooked food back into the plate that had raw food	1	0.9
	Don't know	31	26.7
Is boiling milk the best way of killing microorganisms?	Yes	82	70.7
	No	15	12.9
	Don't know	19	16.4
Is cooking meat thoroughly the best	Yes	76	65.5
	No	19	16.4

Questions	Variables	Frequency	Percentage
way of killing microorganisms?	Don't know	21	18.1
Does refrigeration slow the growth of microorganisms?	Yes	44	37.9
	No	54	46.6
	Don't know	18	15.5
Should we wash meat before freezing?	Yes	104	89.7
	No	7	6.0
	Don't know	5	4.3
Do you wash fruits and vegetables in salt water after purchasing?	Yes	17	14.7
	No	87	75.0
	Sometimes	12	10.3
Defrosted food should not be refrozen.	Yes	48	41.4
	No	57	49.1
	Don't know	11	9.5

Table 2 represents participants' knowledge related to foodborne illnesses and food safety. Most participants (79.3%) were aware of foodborne illnesses and the associated symptoms (75.0%). However, 54 (46.6%) lacked an understanding of refrigeration practices. Furthermore, 69 (59.5%) individuals correctly identified the effective measures to reduce the risk of cross-contamination. Only 7% of the particiapants were aware that meat should not be washed before freezing, and 75% (87) did not follow the practice of washing fruits and vegetables in salt water after the purchase.

Table 3. Assessment of Personal Hygiene Practices among the Study Population

Questions	Variables	Frequency	Percentage
Do you wash your hands after coughing and sneezing?	Yes	29	25.0
	No	39	33.6
	Sometimes	48	41.4
Do you wash your hands with soap after touching your face (such as nose, ear, mouth)?	Yes	42	36.2
	No	44	37.9
	Sometimes	30	25.9
	Yes	111	95.7
	No	1	0.9

Questions	Variables	Frequency	Percentage
Do you wash your hands before and after touching raw meat/chicken?	Sometimes	4	3.4
Do you wash your hands with soap and water after going to the toilet?	Yes	114	98.3
	No	1	0.9
	Sometimes	1	0.9
Do you cover your hair during food preparation?	Yes	56	48.3
	No	44	37.9
	Sometimes	16	13.8

Table 3 demonstrates the personal hygiene practices of the participants. The results demostrated that out of 116 participants, only 29 (25%) followed the hand washing practice after coughing/ sneezing, and only 42 (36.2%) participants washed their hands after touching their face. However, most of the individuals (98.3%) washed their hands with soap right after using the toilet and after touching raw meat/chicken (95.7%). Furthermore, only 56 (48.3%) participants prioritized covering their hair during food preparation.

Table 4. Assessment of Food Purchasing Practices among the Study Population

Questions	Variables	Frequency	Percentage
Do you check the expiry date of food before purchasing?	Yes	40	34.5
	No	33	28.4
	Sometimes	41	35.3
Do you check the food label column before buying food?	Yes	23	19.8
	No	47	40.5
	Sometimes	46	39.7
Do you check vegetables' freshness, color, and crispness before buying?	Yes	99	85.3
	No	7	6.0
	Sometimes	10	8.6
Before buying, do you check fruits' size, firmness, color, and smell?	Yes	106	91.4
	No	2	1.7
	Sometimes	8	6.9
Before purchasing, do you check for bruises,	Yes	95	81.9
	No	5	4.3

Questions	Variables	Frequency	Percentage
blemishes, and spots on fruits and vegetables?	Sometimes	16	13.8
Do you check meat's color, odor, and texture before purchasing?	Yes	59	50.9
	No	49	42.2
	Sometimes	8	6.9

Table 4 represents the food purchasing practices of the study population. The table shows that only 40 individuals (34.5%) reported checking expiration dates, and 23 individuals (19.8%) checked food labels before purchasing food items. In contrast, 99 (85.3%) participants checked for crispness, freshness, and color of vegetables, and 106 (91.4%) evaluated the size, firmness, color, and smell of fruits before the purchase. However, only about half of the individuals (50.9%) examined the color, odor, and texture of meat prior to purchasing.

Table 5. Assessment of Food Preparation and Storage Practices among the Study Population

Questions	Variables	Frequency	Percentage
Do you wash your hands with soap before food preparation?	Yes	103	88.8
	No	4	3.4
	Sometimes	9	7.8
Do you wash vegetables and fruits before cooking?	Yes	115	99.1
	No	0	0
	Sometimes	1	0.9
Do you clean raw meat before cooking?	Yes	116	100.0
	No	0	0
	Sometimes	0	0
Do you use the same cutting board for raw meat, poultry, seafood, and other fresh food and bread?	Yes	34	47.4
	No	54	40.5
	Sometimes	28	12.1
Do you use separate kitchen utensils for raw and cooked food?	Yes	50	43.1
	No	46	39.7
	Sometimes	20	17.2
	At the top	58	50.0
	In the middle	15	12.9

Questions	Variables	Frequency	Percentage
Where should raw meat be stored in the refrigerator?	At the bottom below all food	43	37.1
What is the correct temperature at which frozen food should be kept?	0 degrees	42	36.2
	15 degrees or below	28	24.1
	-18 degrees or lower	12	10.3
	-20 degrees or lower	7	6.0
	don't know	27	23.3
In which containers do you store your food?	Glass containers	18	15.5
	Plastic containers	75	64.7
	Others	23	19.8
What actions do you take on leftover food?	Throw it away	27	23.3
	Store for later use	89	76.7
Should food left out at room temperature for more than 2 hours be discarded?	Yes	48	41.4
	No	68	58.6
Do you use leftover food within 4 days?	Yes	101	87.1
	No	15	12.9

Table 5 indicates the food preparation and food storage practices of the study participants. Out of the total 116 individuals, 34 (47.4%) used the same cutting board for raw and cooked food, and 50 (43.1%) used the same utensils for raw and cooked food. Only 43 (37.1%) participants kept raw meat at the bottom of the refrigerator, and 42 (36.2%) were aware of the appropriate temperature for storing frozen food. Additionally, 64.7% participants stored food in plastic containers instead of glass containers. About 76.7% of participants saved leftover food for later use, and 58.6% did not discard leftover food left at room temperature for more than two hours.

Table 6. Association of Food Safety Knowledge Score with Age, Gender, and BMI

Variable	Pearson Chi-square	df	p-value
Age	50.837	36	0.052
Gender	24.867	9	0.003*
Education	121.205	63	<0.001*

Table 6 shows the association between food safety knowledge with demographic variables, such as age, gender, and education. A statistically significant association was observed between food safety knowledge and both education and gender (p<0.05). The association with age was not statistically significant.

4. DISCUSSION

A study involving domestic food handlers of rural areas of Lahore, Pakistan, showed that the participants had an average knowledge of health risks associated with unhygienic food and poor food safety practices. There was also a significant percentage of illiteracy among the participants [14]. In contrast, the current study demonstrated that participants had a strong knowledge of foodborne illnesses (79.3%) and signs and symptoms of foodborne illnesses (75%). The Food and Drug Administration (FDA) recommends boiling milk and thoroughly cooking meat at proper temperature to reduce the risk of foodborne illnesses. Furthermore, refrigeration prevents bacterial growth [15]. The current study showed 70.7% of participants were aware of the risks of foodborne illnesses associated with unboiled milk and recognized that boiling milk kills bacteria. Similarly, when questioned about cooking meat, 65.5% of participants believed that thoroughly cooking meat is the best approach to kill bacteria, and 37.9% of participants agreed that refrigeration limits the growth of bacteria. The Centers for Disease Control and Prevention states that frequent symptoms of foodborne illnesses include diarrhea, nausea, vomiting, and abdominal discomfort [15].

In the current research, 75% of the respondents had awareness about the symptoms of foodborne diseases. Previous research on foodborne bacterial contamination reported that many of the recorded indirect cross-contamination events occurred when multiple food handlers used shared food contact surfaces, utensils, or equipment [13]. Similarly, in the current study, the majority of participants (59.5%) agreed that cross-contamination

can be prevented by putting raw and cooked food in separate containers. According to a South African study on food safety awareness, there was a substantial association between age and educational level, as well as the temperature range at which the meat was stored in the freezer [16]. Whereas, in the current investigation, only 36.2% of people were aware of the proper refrigeration temperature for the storage of meat. It is well understood that proper personal hygiene is the greatest approach to reducing the risks of foodborne sickness. The FDA recommends that hands should be washed with soap for at least 20 seconds before and after touching food. Recent investigations on food safety difficulties and solutions revealed that one of the practices that contributes to foodborne diseases is poor personal hygiene among individuals during food preparation [14].

However, in the current study, 88.8% of participants washed their hands with soap before meal preparation. While only 25% washed their hands after coughing or sneezing, 98.3% cleaned their hands after using the toilets, and 95.7% washed their hands after touching raw meat. Previous studies have shown that reading food labels may lead towards positive changes in dietary habits. Nutrition facts and ingredient lists, for instance, may influence food choices and improve overall diet quality [15]. In contrast, the current study showed that only 34.5% of participants checked the expiry date, and 19.8% checked food labels before making their purchase. A study conducted in Saudi Arabia concluded that 54.6% of participants washed fruits and vegetables under running water after purchasing them. The majority (78.5%) of respondents utilized separate cutting boards for raw meat and raw fruits and vegetables. Only 30.2% had knowledge about the correct temperature of the refrigerator to store the food, for instance where to store raw meat in the refrigerator as well as the correct temperature to store the meat [13].

Compared to the current study, almost 99% of participants washed fruits and vegetables before cooking but only 40.5% used different cutting boards for raw meat and other food products. Only 43.1% used separate utensils for raw and cooked food products. Like the previous study, this study also revealed that the respondents were unaware of the appropriate temperature for food storage. Additionally, 62.9% of respondents were unaware of the correct storage location for raw meat in the refrigerator [17]. According to the Centre of Science and Environment (USA), washing fruits in 2% salt water is healthy and can eliminate 70-80% of pesticide residue on fruit and

vegetable peels [18]. This study revealed that 75% of participants do not follow this practice. As per the FDA, glass containers are safer to use for food storage compared to plastic containers. In the current study, 64.7% of participants used plastic containers for food storage, whereas 15.5% used glass containers. According to the Food Safety and Inspection Agency, food should be stored within 2 hours of preparation and should not be left at room temperature for longer than 2 hours [5]. However, 58.6% of study participants felt that food should not be discarded if kept out at room temperature for longer than 2 hours.

4.1. Conclusion

In conclusion, the study assessed the knowledge and practices of domestic food handlers regarding food safety practices in Lahore, Pakistan. The findings indicated that the majority of participants were aware of foodborne illnesses. They understand the importance of boiling milk, properly cooking meat, and the importance of proper hand hygiene, particularly washing hands before meal preparation. However, gaps were identified in knowledge regarding refrigeration, correct storage, label checking, and using separate utensils for raw and fresh produce. These findings highlight the need for food safety education and awareness to overcome these gaps and promote safer food handling practices. The risk of foodborne diseases can be reduced by promoting food safety education and emphasizing personal hygiene and proper food handling procedures.

4.2. Recommendations

The current study proposed the following recommendations:

- Strengthen food safety education by implementing comprehensive programs that address key areas, such as expiration dates, food labels, cross-contamination, and proper storage practices.
- Promote personal hygiene practices, including proper handwashing techniques and the use of separate utensils for raw and fresh produce.
- Increase awareness of storage and labeling practices, emphasizing the importance of refrigeration, expiration date checks, and understanding food labels for safe food handling. These measures would help improve food safety practices among domestic food handlers and reduce the risk of foodborne illnesses.

CONFLICT OF INTEREST

The authors of the manuscript have no financial or non-financial conflict of interest in the subject matter or materials discussed in this manuscript.

DATA AVAILABILITY STATEMENT

Data supporting the findings of this study will be made available by the corresponding author upon request.

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No funding has been received for this research.

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