

# Food Safety Knowledge among Food Handlers in Hospitals of Jordan

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**Abstract** Food safety knowledge (FSK) plays an important role in guiding food handlers (FHs) practices during food operations. The aim of this research was to investigate the level of FSK among FHs in hospitals' food services in Jordan. Up to 245 food handlers work in hospitals were purposefully selected from 6 public and private hospitals. A published FSK questionnaire included 120 items in 6 subscales was used to collect data. Most of the hospitals' FHs were male (91.84, n=225), of mean age  $35.89 \pm 9.26$  years, with average experience of  $12.55 \pm 8.1$  years, education of less than high school, and worked in public hospitals. The overall FSK was found to be "moderate" (71.20%). Food handlers were having the highest knowledge in the areas of "personal hygiene and hand washing" (80.87%), "health problems affecting FS" (86.10%), and "cross- contamination control and sanitation" (75.96%). FSK was "moderate" in "thawing, safe storage, transfer, catering, holding, heating, and re-heating" was (68.06%), "foodborne diseases and symptoms" (67.05%), and "poor" in "foodborne pathogens" (30.60%). Male FHs possessed higher FSK than female's counterparts ( $p=0.036$ ). There was a significant negative relationship between FSK and age ( $p=0.044$ ), positive relationship with previous exposure to FS training ( $p=0.000$ ), while there was no significant mean difference of FSK based on the years of experience or hospital sector ( $p=0.090$ ). One-way ANOVA with post-hoc revealed that FHs with higher educational qualification possessed higher FSK ( $p=0.00$ ). Food Safety Training is recommended for certain areas in food operations and foodborne pathogens.

**Keywords** Food Safety, Food Hygiene, Food Safety Knowledge, Food Handlers, Hospitals, Jordan

## 1. Introduction

Food Safety (FS) is emphasized as a basic individual right. Foodborne diseases represent a considerable burden to public health and continue to challenge health systems worldwide [1]. Data suggest that foodborne diseases are common throughout the world; however, because of the limitations of surveillance systems, only a small proportion of the actual number of cases is reported [2]. Available estimates emphasize that there are about 600 million people fall ill worldwide annually for consuming contaminated food, with diarrheal diseases being the most common form of these illnesses [3]. It has been reported that foodborne diseases are reasons behind 70% of diarrheal diseases in developing countries due to lack of personal hygiene and FS measures [4].

In the industrialized countries, several studies indicate that a great proportion of foodborne diseases are associated with foodservices establishments including hospitals [5]. It has been indicated that many foodborne diseases are transmitted to patients in hospitals that may worsen their condition, specially, if they are immunosuppressed [6]. These diseases are caused by a variety of chemicals or pathogenic microorganisms that may contaminate food at different steps of its preparation

[7, 8].

Foodborne diseases transmission was identified by the Food and Drug Administration (FDA) to be associated with multiple factors including mishandling practices by Food Handlers (FHs) [9] and their non-compliance with FS practices [10]. FHs may contaminate food during catering or any step of food preparation by poor personal hygiene and sanitation, cross contamination from other food material, insufficient cooking time, or inappropriate storage temperature [1]. These malpractices were linked to the level of knowledge about basics of FS that FHs possess relevant to the aspects of these issues [11, 12]. Knowledge plays a significant role in guiding and directing practices, behaviors and attitudes of individuals [13, 14].

Many studies have been conducted in Jordan investigated Food Safety Knowledge (FSK) among foodservices staff, in restaurants [15], universities foodservices [16], food handling practices among foodservices' employees in Irbid City [17], studies investigating FHs knowledge relevant to FS in Jordanian hospitals were scarce. The aim of this study was to evaluate the FSK of hospitals' FHs in Jordan.

## 2. Materials and Methods

### *Settings*

This study has been conducted in 6 (private & public) hospitals in Amman, Jordan. The study units were selected using simple random technique from 20 public and private hospitals in Amman, the capital of Jordan.

### *Research Design*

A cross sectional study design was used to conduct the study in the period between January and June 2020 to evaluate the FSK among FHs of hospitals' foodservices in Amman, Jordan.

### *Participants*

After identification of the study settings, the total sample size was calculated. For this study, to make sure that the sample size is sufficient to get statistical significance, sample size has been determined using G\* power 3.1 software, a power of 0.80, an alpha level of 0.05, and a medium effect size of 0.25 [18]. Based on these assumptions, the estimated sample size was 240 participants. Drop out of participants, non-response, or no return of the questionnaire is expected in the research. The researchers added 10% (24) participants for the estimated sample size. Accordingly, the final estimated sample size was 264 participants of FHs in the hospitals' foodservices. The estimated sample size was proportionally distributed in the six hospitals based on the count of FHs at each

hospital. The primary researcher himself collected the data from the selected participants.

### *Data Collection Tools*

A 2-part self-reported questionnaire has been used. The first part was developed by the researchers to collect data about the characteristics of the participants (age, gender, education, years of experience, and previous exposure to FS training) and the selected settings characteristics (sector of hospital). The second part was the Food Safety Knowledge Questionnaire (FSKQ) which was adopted from previous validated questionnaires published on FS issues [15, 19-23]. The questionnaire included 120 questions covering 6 FSK areas, "personal hygiene and handwashing" (23 questions); "health problems that affect FS" (9 questions); "foodborne diseases symptoms" (13 questions); "cross- contamination control and sanitation" (32 questions); thawing, safe storage, transfer, catering, holding, heating and re-heating (31 questions); and "foodborne pathogens and conditions that can cause food poisoning" (12 questions). The responses of the participants were requested to be given as "Yes"/"No", and "don't know" to each query statement in the questionnaire.

The questionnaire was originally published in English. To ensure its validity, translation to Arabic and back translation into English by two independent official bilingual translators were performed. The two English versions, the original as well as the back translated, were matched to check if major changes in the meaning of any of the items which was not evident. The questionnaire reliability was checked using test-retest reliability. The Pearson correlation coefficient was calculated ( $r^2 = .76$ ).

### *Statistical Analysis*

All data were entered to the Statistical Package for the Social Sciences (SPSS) Version 21 (SPSS, Inc. Chicago, IL., USA). Descriptive statistics were calculated for all variables. Independent sample t-test was performed to compare the FSK of categorical sample characteristics (gender, hospital sector). One-way Analysis of Variance (ANOVA) with post-hoc was performed to compare the FSK across groups of FHs based on their educational levels (4 groups). Correlation was run to investigate the relationships of FSK mean scores and continuous sample characteristics (age, experience, and previous exposure to FS training). A  $p$  value of .05 was considered to be statistically significant. The total FSK of FHs was evaluated by summation of the correct responses of the 120 questions included in the 6 categories of FS (maximum score is 120). A point of "1" was assigned for the correct answer and a "0" point was assigned for the wrong/ don't know answer. Then, the score was converted to a percentage by dividing the total score by the maximum score (score/maximum score\*100). The knowledge raw scores were divided into quartiles. The FH

was considered as having an "excellent" knowledge if his/her score falls above the 75<sup>th</sup> percentile (75%) for the overall FSK and for each category on the scale. A FSK level of 50% -75% was considered as "moderate knowledge", and a "poor knowledge" if the FSK level falls below 50% [24]. The hospitals' FHs must be at certain high level of FSK as they provide food for patients that might be immunosuppressed or have no choices but hospitals' food.

### 3. Results

#### Demographic Characteristics of the Participants

A total of 264 questionnaires were distributed, 245

questionnaire returned back (response rate= 92,8%) and included in the final analysis. Most of the study sample was composed of male gender (91.84%, n= 225) compared to their counterpart female gender (8.16%, n= 20) with a mean age of 35.89(SD=9.26) yrs, and average years of experience was 12.55 (SD= 7.6) yrs. In terms of education, there was 57.1% (n= 140) with less than high school, 19.2% (n= 47) with high school certificate, 16.7%, (n=41) holding a Diploma degree, and 6.9% (n=17) were BSc certified. Relevant to hospitals' sectors, 134 (55.0%) FHs were recruited from the public sector and 111 (45.0%) from private sector. From the total sample, only 8.2% (n=20) FHs had been exposed to previous training in FS courses compared to 91.8% (n=225) of the participants whom didn't have any form of training (**Table 1**).

**Table 1.** Descriptive Statistics of Sociodemographics and Settings Characteristics (n- 245)

Category	Subcategory	N	%	Mean (SD)
Gender	Male	225	91.84%	
	Female	20	8.16%	
	Total	245	100.0%	
Age (Years)				35.89 (9.26)
Experience (Years)				12.55 (8.1)
Educational Level	Less than high school	140	57.1%	
	High school	47	19.2%	
	Diploma	41	16.7%	
	BSc	17	6.9%	
	Total	245	100.0%	
Previous Training	Yes	20	8.2%	
	No	225	91.8%	
	Total	245	100.0%	
Hospital Sector	Public	134	55%	
	Private	111	45%	
	Total	245	100%	

**Table 2.** Means, SD, and Percentages of FSK, and FSK Subscales (N=245)

The Query Statement	Minimum	Maximum	Mean	SD	%
Personal Hygiene & Hand Washing	13.00	21.00	18.60	1.58	80.87%
Health Problems affecting FS	3.00	9.00	7.75	1.36	86.10%
cross contamination control & sanitation	12.00	32.00	24.31	4.71	75.96%
Thawing, Safe Storage, Transfer, Catering, Holding, Heating, and Re-Heating	10.00	31.00	21.31	4.16	68.06%
Foodborne Diseases & Symptoms	5.00	13.00	8.71	2.32	67.05%
Foodborne Pathogens	.00	12.00	4.71	3.26	30.60%
Overall FSK	54.00	114	85.434	10.41	71.20%

### The Overall FSK

The overall FSK mean score in the current study was 85.43/ 120 points corresponded to 71.2%, which was considered to be "moderate". FHs scored as highest in the areas of "personal hygiene and hand washing", mean score was 18.60/23 points (80.87%), then in the "health problems affecting FS", the mean score was 7.67/9 points (86.1%), followed by "cross contamination control and sanitation" where the mean score was 24.31/32 points (75.96%). FHs scored "moderate" FSK in the "thawing, safe storage, transfer, catering, holding, heating, and re-heating", the mean score was 21.10/31 points (68.06%), and in "foodborne diseases and symptoms", the mean score was 8.71/13 (67.05%). The lowest FSK was relevant to "foodborne pathogens where the mean score was 5.02/12 (30.60%) (Table 2).

**Personal Hygiene & Hand Washing:** Only for 3 items on subscale of the "personal hygiene and hand washing", FHs scored above the 75<sup>th</sup> percentile for each of the given query statement (**Table 3**). The three items were "washing hands after touching sanitized countertop", and "it is important to wash hands during continuous food handling", the percentages of correct responses were 26.9% and 33.1% respectively.

**Health Problems Affecting FS:** FHs were also found to have a "good" FSK in health problems affecting FS. Participants scored higher than the 75<sup>th</sup> percentile in response to 8 questions out of the given 10 questions. They scored lowest in response to 2 of the given question, "smoking during working would affect FS", and "diarrhoea would affect FS" (the percentage of correct responses was 64% and 61% respectively), (**Table 4**).

**Table 3.** Mean & SD of FHs FSK in "Personal Hygiene & Hand Washing (n=245)

The Query Statement	Minimum	Maximum	Mean	SD	% of Correct Responses
It is important to wash hands after touching money.	.00	1.00	.935	.25	93.5%
It is important to wash hands after removing gloves.	.00	1.00	.918	.27	91.8%
It is important to wash hands before wearing gloves.	.00	1.00	.943	.23	94.3%
It is important to wash hands after using mobile phone.	.00	1.00	.943	.23	94.3%
It is important to wash hands after touching work clothes.	.00	1.00	.943	.23	94.3%
It is important to wash hands after handling the garbage.	.00	1.00	.988	.11	98.8%
It is important to wash hands after cleaning tables.	.00	1.00	.963	.19	96.3%
It is important to wash hands after blowing of nose.	.00	1.00	.951	.22	95.1%
Washing hands after touching sanitized countertop.	.00	1.00	.269	.45	26.9%
It is important to wash hands after eating meals.	.00	1.00	.980	.14	98.0%
It is important to wash hands before preparing meals.	.00	1.00	.95.9	.20	95.9%
It is important to wash hands after using toilets.	.00	1.00	.943	.23	94.3%
It is important to wash hands after handling raw meats or poultry.	.00	1.00	.939	.24	93.9%
It is important to wash hands after touching the body.	.00	1.00	.922	.27	92.2%
It is important to wash hands during continuous food handling.	.00	1.00	.331	.47	33.1%
It is necessary to wear gloves before touching Ready-to-Eat food product.	.00	1.00	.927	.26	92.7%
It is important to wear gloves before food handling or preparation.	.00	1.00	.976	.16	97.6%
The Duration of Hand Washing is $\geq$ 20 seconds.	.00	1.00	.971	.167	97.1%
Hand washing should be under running water.	.00	1.00	.959	.20	95.9%
Hand washing should be in a basin of warm water.	.00	1.00	.964	.46	96.4%
It is important to wash hands after shaking hands with others.	.00	1.00	.943	.26	94.3%
It is important to wash hands after touching objects and surfaces	.00	1.00	.931	.23	93.1%
It is necessary to have annual health checkup.	.00	1.00	.963	.19	96.3%

Note: The query statement appears in bold is a correct statement.

**Table 4.** Mean & SD of FHs FSK in "Health Problems that would affect FS" (n=245)

The Query Statement	Minimum	Maximum	Mean	SD	% of Correct Responses
Sneezing would affect food safety.	.00	1.00	.943	.23	94.3%
Coughing would affect food safety.	.00	1.00	.931	.26	93.1%
Smoking during working would affect food safety.	.00	1.00	.631	.48	63.1%
Diarrhea would affect food safety.	.00	1.00	.608	.49	60.8%
Vomiting would affect food safety.	.00	1.00	.861	.35	86.1%
Sore throat would affect food safety.	.00	1.00	.889	.31	88.9%
Fever would affect food safety.	.00	1.00	.911	.27	91.1%
Food contamination can't be recognized by appearance, smell or by taste.	.00	1.00	.902	.30	90.2%
Covered hand wound with wearing a glove can affect food safety.	.00	1.00	.976	.16	97.6

Note: The query statement appears in bold is a correct statement

**Cross- Contamination Control & Sanitation:** FHs in "cross- contamination control and sanitation" were considered to have a "good" FSK. However, FHs in the current study scored low in several critical issues where they didn't correctly answer the questions relevant to: used dishes must be soaked in water for several hours then washed with the same water (*Correct Responses: 44%*), used dishes must be washed in water basin than dried with dish cloth (*Correct Responses: 34%*), wash knife used to cut raw meat or poultry with water before using it to chop vegetables (*Correct Responses: 59%*), wash knife used to cut raw meat or poultry with water and soap then apply sanitizer before using it to chop vegetables (*Correct Responses: 46%*), wash knife used to cut raw meat or poultry with hot water before using it to chop vegetables (*Correct Responses: 45%*), wash cutting board used to cut raw meat or poultry with water and soap then apply sanitizer before using it to chop vegetables (*Correct Responses: 33%*), store vegetables salad in the upper shelf in refrigerator if raw meat or chicken in middle shelf (*Correct Responses: 37%*), store vegetables salad in upper shelf in the meat or poultry refrigerator (*Correct Responses: 47%*), wash vegetables & fruits under warm running water (*Correct Responses: 42%*), wash knife used to cut raw meat or poultry with water and soap then apply sanitizer before using it to chop vegetables (*Correct Responses: 46%*) (**Table 5**).

**Thawing, Safe Storage, Transfer, Catering, Holding, Heating, and Re-heating:** FHs were found to be having "moderate" knowledge in the "food handling practices". However, FHs scored low in response to questions about critical issues in food handling: "food should reach 73 °C during reheating" (*Correct Responses: 44.9%*), "freshly prepared food, that will be consumed after 3 hours, should be stored in the microwave" (*Correct Responses: 51.4%*), "discard leftover if not eaten completely (*Correct Responses:*

*33.9%*), "store leftover on steam table" (*Correct Responses: 39.2%*), "the correct way of reheating the leftover food is until boiling" (*Correct Responses: 42%*), "hot RTE foods storage temperature is > 61°C (serving temperature)" (*Correct Responses: 42.9%*), "checking poultry is sufficiently cooked by touching" (*Correct Responses: 48.6%*), "checking poultry is sufficiently cooked by experience" (*Correct Responses: 34.3%*), "checking poultry is sufficiently cooked by expel its water" (*Correct Responses: 48.6%*), thawing frozen raw meat or poultry in the microwave" (*Correct Responses: 36.7%*), "thawing frozen raw meat or poultry in still water" (*Correct Responses: 51%*), "thawing frozen raw meat or poultry in the refrigerator" (*Correct Responses: 54.7%*), and "thawing frozen raw meat or poultry in the microwave" (*Correct Responses: 36.7%*), (**Table 6**).

**Foodborne Diseases and Symptoms:** Knowledge in the area of foodborne diseases and symptoms was "moderate". Respondents scored low in some questions: "food poisoning can result from food contamination with molds, fungi, or yeast" (*Correct Responses: 57.6%*), "food poisoning can result from eating uncooked beef or eggs" (*Correct Responses: 51.8%*), "food poisoning can result from eating uncooked canned food" (*Correct Responses: 47.4%*), "pain in the bone is a symptom of foodborne illnesses" (*Correct Responses: 28.2%*), "coughing or sneezing is a symptom of foodborne illnesses" (*Correct Responses: 40%*), "hypoglycaemia is a symptom of foodborne illnesses" (*Correct Responses: 53.9%*), and "headache is a symptom of foodborne illnesses" (*Correct Responses: 32.2%*) (**Table 7**).

**Foodborne Pathogens Causing Foodborne Diseases:** FHs scored as highest only in response to "Salmonella" as foodborne pathogen (*Correct Responses: 82.5%*), while they scored lower than the 75th percentile in the remained 12 questions (**Table 8**).

**Table 5.** Mean & SD of FHs FSK in "Cross Contamination Control & Sanitation" (n=245)

The Query Statement	Minimum	Maximum	Mean	SD	% of Correct Responses
Cross contamination is the transmission of harmful microorganism from food handler to the food.	.00	1.00	.898	.30	89.8%
Cross Contamination is the transmission of harmful microorganism from food to food.	.00	1.00	.890	.31	89.0%
Hand washing after handling raw material can prevent cross contamination	.00	1.00	.849	.36	84.9%
Raw and cooked food must be separated during preparation & refrigeration.	.00	1.00	.841	.37	84.1%
Used dishes must be washed immediately after meal.	.00	1.00	.902	.29	90.2%
Used dishes must be soaked in water for several hours then washed with the same water.	.00	1.00	.441	.49	44.1%
Used dishes must be washed in water basin then dried with dish cloth.	.00	1.00	.339	.47	33.9%
Use the same knife to cut raw meat or poultry and to chop vegetables.	.00	1.00	.914	.28	91.4%
Wash knife used to cut raw meat or poultry with cold water before using it to chop vegetables.	.00	1.00	.906	.29	90.6%
Wash knife used to cut raw meat or poultry with hot water before using it to chop vegetables.	.00	1.00	.445	.49	44.5%
Wash knife used to cut raw meat or poultry with water before using it to chop vegetables.	.00	1.00	.584	.49	58.4%
Wash knife used to cut raw meat or poultry with water and soap then apply sanitizer before using it to chop vegetables.	.00	1.00	.461	.49	46.1%
Wipe knife used to cut raw meat or poultry with a piece of cloth before using it to chop vegetables.	.00	1.00	.861	.35	86.1%
Change knife to cut raw meat or poultry and to chop vegetables.	.00	1.00	.898	.30	89.8%
Use same cutting board to cut raw meat or poultry and to chop vegetables.	.00	1.00	.939	.24	93.9%
Wash cutting board used to cut raw meat or poultry with cold water before using it to chop vegetables.	.00	1.00	.865	.34	86.5%
Wash cutting board used to cut raw meat or poultry with hot water before using it to chop vegetables.	.00	1.00	.825	.38	82.4%
Wash cutting board used to cut raw meat or poultry with water and soap before using it to chop vegetables.	.00	1.00	.865	.34	86.5%
Wash cutting board used to cut raw meat or poultry with water and soap then apply sanitizer before using it to chop vegetables.	.00	1.00	.331	.47	33.1%
Wipe cutting board used to cut raw meat or poultry with a piece of cloth before using it to chop vegetables.	.00	1.00	.849	.36	84.9%
Change cutting board to cut raw meat or poultry and to chop vegetables.	.00	1.00	.886	.32	88.6%
Wash surfaces (countertops) with water and soap then apply a sanitizer is the most effective method in cleaning and sanitize food contact surfaces.	.00	1.00	.869	.34	86.9%
Store vegetables salad in the upper shelf in refrigerator if raw meat or chicken in middle shelf.	.00	1.00	.371	.48	37.1%
Store vegetables salad in middle shelf in refrigerator if raw meat or chicken in middle shelf.	.00	1.00	.849	.36	84.9%
Store vegetables salad in the lower shelf in refrigerator if raw meat or chicken in middle shelf.	.00	1.00	.841	.37	84.1%
Store vegetables salad in meat or poultry refrigerator.	.00	1.00	.898	.30	89.8%
Store vegetables salad in upper shelf in the meat or poultry refrigerator.	.00	1.00	.474	.50	47.4%
Wash vegetables & Fruits under warm running water.	.00	1.00	.416	.49	41.6%
Wear gloves before touching Ready-to-Eat food products.	.00	1.00	.894	.31	89.4%
Wear gloves when touching or distributing unwrapped food products.	.00	1.00	.865	.34	86.5%
Wear work clothes or uniform during touching or distributing unwrapped food products.	.00	1.00	.918	.27	91.8%
Wear hair net during touching or distributing unwrapped food products.	.00	1.00	.886	.32	88.6%

Note: The query statement appears in bold is a correct statement

**Table 6.** Mean & SD of FHs FSK in "Thawing, Safe Storage, Transfer, Catering, Holding, Heating, and Re-heating" (n=245)

The Query Statement	Minimum	Maximum	Mean	SD	% of Correct Responses
Time and temperature are the most important factors in controlling bacterial growth.	.00	1.00	.918	.27	91.8%
Refrigerator operating temperature must be 1-5 °C.	.00	1.00	.878	.33	87.8%
The refrigerator & freezer temperature must be checked and recorded on daily basis.	.00	1.00	.918	.27	91.8%
Food should reach 73 °C during reheating.	.00	1.00	.449	.49	44.9%
Freshly prepared food, that will be consumed after 3 hours, should be stored in the microwave.	.00	1.00	.514	.50	51.4%
Freshly prepared food, that will be consumed after 3 hours, should be stored in the refrigerator then reheat when to be consumed.	.00	1.00	.874	.33	87.4%
Discard leftover if not eaten completely.	.00	1.00	.339	.47	33.9%
Store leftover in the oven.	.00	1.00	.853	.35	85.3%
Store leftover on the shelf in the kitchen.	.00	1.00	.861	.35	86.1%
Store leftover on the countertop or table in the kitchen.	.00	1.00	.841	.37	84.1%
Store leftover in the refrigerator.	.00	1.00	.645	.48	64.5%
Leftover food can be kept refrigerated for more than 3 days.	.00	1.00	.825	.38	82.4%
Store leftover on steam table.	.00	1.00	.392	.49	39.2%
The correct way of reheating the leftover food is until boiling.	.00	1.00	.420	.83	38.0%
Hot RTE foods storage temperature is > 61°C. (serving temperature).	.00	1.00	.429	.50	42.9%
Temperature of chicken tissue should reach 74°C during cooking.	.00	1.00	.837	.37	83.7%
Checking poultry is sufficiently cooked by touching.	.00	1.00	.486	.50	48.6%
Checking poultry is sufficiently cooked by experience.	.00	1.00	.343	.48	34.3%
Checking poultry is sufficiently cooked by thermometer.	.00	1.00	.853	.35	85.3%
Checking poultry is sufficiently cooked by expel its water.	.00	1.00	.486	.50	48.6%
Checking poultry is sufficiently cooked by appearance.	.00	1.00	.735	.44	73.5%
Thawing frozen raw meat or poultry on the kitchen counter in covered container.	.00	1.00	.796	.40	79.6%
Thawing frozen raw meat or poultry on the kitchen counter in an open container.	.00	1.00	.837	.37	83.7%
Thawing frozen raw meat or poultry in still water.	.00	1.00	.510	.50	51.0%
Thawing frozen raw meat or poultry in the refrigerator.	.00	1.00	.547	.50	54.7%
Thawing frozen raw meat or poultry in the microwave.	.00	1.00	.367	.48	36.7%
Refreeze thawed meat for later use.	.00	1.00	.841	.37	84.1%
Freezer operating temperature is ~18 °C.	.00	1.00	.784	.41	78.4%
Can all forms of bacteria have killed by freezing?	.00	1.00	.861	.35	86.1%
Thawed meat should be cooked immediately.	.00	1.00	.849	.36	84.9%
The optimal Temperature for bacterial growth is between 5°C – 61°C (Danger Zone).	.00	1.00	.808	.40	80.8%

Note: The query statement appears in bold is a correct statement

**Table 7.** Mean & SD of FHs FSK in "Foodborne Diseases and Symptoms" (n=245)

The Query Statement	Minimum	Maximum	Mean	SD	
Food poisoning can result from food contamination with molds, fungi, or yeast.	.00	1.00	.576	.50	57.6%
Food poisoning can result from eating uncooked beef or eggs.	.00	1.00	.518	.50	51.8%
Food poisoning can result from eating uncooked canned food.	.00	1.00	.474	.50	47.4%
Abdominal pain is a symptom of foodborne illnesses.	.00	1.00	.959	.20	95.9%
Diarrhea is a symptom of foodborne illnesses.	.00	1.00	.959	.20	95.9%
Coughing or sneezing is a symptom of foodborne illnesses.	.00	1.00	.400	.50	40.0%
Hair Loss is a symptom of foodborne illnesses.	.00	1.00	.902	.30	90.2%
Pain in the bone is a symptom of foodborne illnesses.	.00	1.00	.282	.45	28.2%
Headache is a symptom of foodborne illnesses.	.00	1.00	.322	.47	32.2%
Vomiting is a symptom of foodborne illnesses.	.00	1.00	.902	.30	90.2%
Hypoglycemia is a symptom of foodborne illnesses.	.00	1.00	.539	.50	53.9%
Hypertension is a symptom of foodborne illnesses.	.00	1.00	.878	.33	87.8%
Nausea is a symptom of foodborne illnesses.	.00	1.00	.918	.28	91.8%

Note: The query statement appears in bold is a correct statement

**Table 8.** Mean & SD of Food Handlers FSK on "Foodborne Pathogens" (n=245)

The Question	Minimum	Maximum	Mean	SD	% of Correct Responses
<b>Salmonella.</b>	<b>.00</b>	<b>1.00</b>	<b>.825</b>	<b>.38</b>	<b>82.5%</b>
<b>Listeria Monocytogenesis.</b>	<b>.00</b>	<b>1.00</b>	<b>.408</b>	<b>.49</b>	<b>40.8%</b>
<b>Staphylococcus aureus.</b>	<b>.00</b>	<b>1.00</b>	<b>.514</b>	<b>.50</b>	<b>51.4%</b>
<b>Bacillus aureus.</b>	<b>.00</b>	<b>1.00</b>	<b>.306</b>	<b>.46</b>	<b>30.6%</b>
<b>E. Coli.</b>	<b>.00</b>	<b>1.00</b>	<b>.274</b>	<b>.45</b>	<b>27.4%</b>
<b>Clostridium perfringens.</b>	<b>.00</b>	<b>1.00</b>	<b>.335</b>	<b>.47</b>	<b>33.5%</b>
<b>Campylobacter.</b>	<b>.00</b>	<b>1.00</b>	<b>.220</b>	<b>.42</b>	<b>22.0%</b>
<b>Shigella.</b>	<b>.00</b>	<b>1.00</b>	<b>.367</b>	<b>.48</b>	<b>36.7%</b>
<b>Hepatitis A.</b>	<b>.00</b>	<b>1.00</b>	<b>.204</b>	<b>.40</b>	<b>20.4%</b>
Washing the food with very hot water can prevent Salmonella contamination.	.00	1.00	.347	.48	34.7%
Freezing the food for more than 3 days can control Salmonella infection.	.00	1.00	.392	.50	39.2%
Raw pork and beef are the most likely food to become contaminated with listeria..	.00	1.00	.441	.50	44.1%

Note: The query statement appears in bold is a correct statement.

### FSK & Sociodemographics

**FSK Level & Gender:** with respect to gender, the number of participating female gender was low (59) compared to the male gender. A significant statistical mean difference in the total FSK scores with respect to the gender  $t(244) = 2.108$ ,  $p < 0.05$  was revealed by this study. Males had a higher mean score of FSK ( $M=85.90$ ,  $SD=9.91$ ) than females ( $M=80.75$ ,  $SD=15.58$ ) (**Table 9**).

**FSK Level & Continuous Sample Characteristics (Age, Years of Experience):** Pearson product-moment correlation showed that there is a statistical significant relationship between age and FSK score ( $R=-1.129$ ,  $n=245$ ,  $p=0.044$ ), younger FHs possessed higher FSK mean score. While, no statistical significant association between the years of experience and FSK score ( $R=-$

$0.109$ ,  $n=245$ ,  $p=.090$ ) (**Table 10**).

**FSK Level & Hospital's Sector:** An independent sample t-test revealed that there is no statistically significant difference in the total FSK score with respect to hospitals' sector  $t(232) 1.096$ ,  $p < 0.05$ . FHs in the public hospitals were found to have a non-statistically slightly higher FSK mean score ( $86.15 \pm 12.21$ ) compared to FHs in the private sector hospital ( $84.67 \pm 8.07$ ),  $p=0.274$  (**Table 11**).

**FSK & Level of Education:** A between groups one-way ANOVA with post-hoc has yielded that there were significant statistical mean differences in FSK scores between the educational categories  $F(3, 241) = 16.657$ ,  $p=0.000$ . FHs holding a BSc were found to have the highest significant FSK mean scores ( $92.9 \pm 6.24$ ),



followed by Diploma qualified FHs ( $92.2 \pm 11.63$ ), high school certified have the mean of  $84.7 \pm 13.08$ , while FHs with less than high school educational level were of the significantly lowest FSK scores  $79.3 \pm 8.83$  (Table 12).

**FSK & Previous Training:** Pearson product-moment correlation showed that there is a statistical significant association between "previous training" and FSK score ( $R = .681^{**}$ ,  $n=245$ ,  $p=0.000$ ) (Table 13).

**Table 9.** t-test Analysis of the FSK according to Gender

Variables	N	Mean $\pm$ SD	Df	T value	P value	
Gender	Male	225	85.90 $\pm$ 9.91	244	2.108	0.036
	Female	20	80.75 $\pm$ 15.58			

**Table 10.** Pearson Product-Moment Correlation Analysis of FSK and Continuous Variables (Age & Years of Experience)

		TFSK	Age (Yrs)	Exp (Yrs)
TFSK	Person Correlation	1	-1.129*	-.109
	Sig. (2 tailed)		.044	.090
	N		245	245
Age (Yrs)	Person Correlation		1	.899**
	Sig. (2 tailed)			.000
	N			245
Experience (Yrs)	Person Correlation			1
	Sig. (2 tailed)			
	N			245

\*\* Correlation is significant at the 0.01 level (2-tailed).

\* Correlation is significant at the 0.05 level (2-tailed).

**Table 11.** t-test Analysis of the FSK According to Hospital Sector

Variables	N	Mean $\pm$ SD	Df	T value	P value	
Hospitals' sector	Public	134	86.15 $\pm$ 12.21	232	1.096	0.274
	Private	111	84.67 $\pm$ 8.07			

**Table 12.** A One-Way ANOVA Analysis of the FSK according to Educational Level

Educational level	N	Mean $\pm$ SD	Sum of squares	Df	F	P value
less than high school	47	79.3 $\pm$ 8.83	Between groups	3	16.657	0.000
High school	140	84.7 $\pm$ 13.08				
Diploma	41	92.2 $\pm$ 11.63	Within groups	241.00		
BSc	17	92.9 $\pm$ 6.24				

\* The mean difference is significant at 0.05 level (2-tailed).

**Table 13.** Pearson Correlation of FSK & Previous Training (n=245).

Category	Previous Training	TFSK
Previous Training	Person Correlation	1
	Sig. (2-tailed)	.681**
	N	245
TFSK	Person Correlation	1
	Sig. (2-tailed)	.681**

\*\*Correlation is significant at the 0.001 level (2-tailed).

## 4. Discussion

The overall FSK mean score in the current study is considered to be "moderate". This finding emphasizes the necessity for FS training to enhance knowledge in this regard and protect food consumers at hospitals (patients as well as hospitals' employees) against foodborne and other diseases. Knowledge plays a significant role in guiding and directing, practices, behaviors and attitudes of individuals [13]. However, the possession of sufficient FSK has not always been found to translate into safe food handling practices [25, 26]. Based on this fact, FHs' practices must be assessed to confirm the transferability their knowledge into practice.

FHs possessed a "good" knowledge in "personal hygiene and hand washing" area. Hand hygiene plays a significant role in breaking the cross contamination cycle. Inconsistently, a previous study showed that FHs had a very poor to good knowledge in "personal hygiene" aspects [27]. FHs' faulty responses for the 3 questions on "personal hygiene and hand washing" questions represented an exaggeration of their hand hygiene, as washing hands during continuous working or after touching sanitized countertop is not necessary. Their response could be attributed to an increased awareness toward prevention of COVID-19 virus disease by extensive personal hygiene and handwashing. Hand hygiene is the key of breaking the cross-infection chain in the hospital settings. Good personal hygiene and handwashing contributes to the prevention of food borne pathogens being transmitted from the FHs to food [28]. The World Health Organization (WHO) has further emphasized this issue by launching its advice about the necessity that food workers have to consider personal hygiene and hand washing and to keep all workers in the food production and supply chains healthy and safe so consumers of their food can survive the current pandemic of COVID-19. Moreover, adherence of FHs to the personal hygiene principles such as handwashing and the use of protective equipment (mask and gloves) in addition to social distancing is essential to stay safe and reduce the risk of the transmission of COVID-19 to each other's and to patients when providing food [1].

Knowledge about health problems and conditions that can affect FS was also sufficient in the current study. Similar conclusions were made by recent studies in Jordan [27, 29]. Knowledge about this category of FS can help FHs identify the type of their illness or wellness level that can impact the FS. Lacking awareness about the health problems or conditions affecting FS may lead to underestimation of these issues and can result in food contamination through food handling. While, awareness about the impact of some health problems like diarrhoea, or the condition of smoking on FS, can contribute to prevention of food being contaminated. As per the Codex Alimentarius Commission (CAC) recommendations, FHs

should properly wash their hands at every stage of food production to protect the consumers against foodborne illnesses, particularly, before handling meat, after eating, smoking, coughing, sneezing, touching garbage and using toilet use to protect the food from contamination [30].

Cross contamination control and sanitation is a critical aspect that must be highly considered while handling food which was found to be "good" in this study. Consistently, FHs had a sufficient knowledge on "cross contamination control and sanitation" aspect [27], and scored as highest in a recent study [29]. The role of extensive public awareness and orientation about hand washing along with disinfecting surfaces as a prophylaxis against COVID-19 virus disease might be the reason behind this satisfactory result. Since September 2019, the world is encountered with the threat of the COVID-19 pandemic. However COVID-19 virus is a respiratory illness and there is lack of evidence that this virus is transmitted by food, there is still a chance for the virus to be transmitted to and from the hospitalized patients or FHs through a provision of food or handling the used cutlery by COVID-19 infected patients. Recent research reported that COVID-19 virus can survive on different surfaces such as plastic, copper, cardboard, and stainless steel for up to 72 hours [31]. The WHO and the Food and Agriculture Organization (FAO) of the United Nations made a call for food industries and food services departments as they must adopt Food Safety Management Systems (FSMS) [1]. This can be reinforced by implementation of personal hygiene measures and provision of food hygiene principles training to minimize the risk of food surfaces and food packaging materials becoming contaminated with the virus from food workers. Additionally, Personal protective equipment (PPE), such as masks and gloves, if they are properly used, can be effective in reducing the spread of viruses and disease within the food industry. In addition to physical distancing, the foodservice is strongly advised to imply strict hygiene and sanitation measures and to promote frequent and effective handwashing and sanitation at each stage of food operations. These measures can protect the food and protect against spreading of COVID-19 among workers [1].

Knowledge about food operations (Thawing, Safe Storage, Transfer, Catering, Holding, Heating, and Re-heating), or in another words, food time and temperature control, is critical to ensure FS. Food handling temperature is critically important in minimizing the point at which food will spoil and become unsafe for consumption. Temperature abuse can occur at any step along the food operation chain. This improper food temperature control can also occur if FHs do not consider the correct catering, storing, reheating, or receiving temperatures [32]. Cooler temperature is helpful in reducing the rate of food poisoning as it slows down the multiplication of pathogens in the food that may hinder food spoilage [33]. The findings from the current study

were further supported by a previous study in Jordan where FHs were found to be having a "very poor" to "good" knowledge in food handling operations [27]. Improved knowledge in addition to practices in this area has been associated with food handling training [17, 21]. These findings emphasize the necessity of training of FHs in this regard.

Contrarily, FS had significantly increased the knowledge scores but did not contribute to significant improvement in food handling practices ( $p > 0.05$ ) [34]. Inspection scores for the intervention group, especially in areas such as handwashing, food handling practices and checking and recording food temperatures [34]. It has been reported that most observed violations were with respect to personal hygiene (specifically lack of proper hand washing), followed by holding of prepared food at the correct temperature, hand washing, thermometer use, and proper handling of food and work surfaces [35]. Factors influencing transfer of knowledge into practice should also be investigated.

Insufficient knowledge about foodborne disease and health problems affecting FS can lead to inability of FHs to be aware about the seriousness of the issue of food poisoning and other foodborne diseases. Our findings came in line with previous studies [27, 36]. Although the overall score of the subscale of the foodborne diseases and its symptoms is low, respondents correctly responded to a well - known symptoms of food poisoning including nausea, vomiting, abdominal pain, and diarrhoea. This knowledge is frequently emphasized by the mass and social media as a major manifestation of foodborne diseases.

Foodborne diseases are primarily caused by certain bacterial pathogens as *Salmonella*, *Campylobacter*, *Enterohaemorrhagic Escherichia coli* (EHEC), and *Listeria monocytogenes*, and some viruses such as norovirus and typhoid [37]. FHs were not fully aware about these groups of pathogens that can cause foodborne diseases as they scored as the lowest. Knowledge about microbial hazards among FHs was "poor" in our findings. This can be attributed to the lack of training about these microbial hazards in foods [38]. The fact that pathogens in food will grow rapidly when food is subjected to temperatures of 37°C or above is critical for correct handling of food and the prevention of food spoilage [14, 39]. The possession of inadequate knowledge of microbial hazards and critical temperature ranges by FHs has been reported in many studies [40, 41] where the level of training and education was reported to be a predictor for better knowledge relevant to food temperature control [16]. Similar findings about low FSK levels in this area were reported [11, 42]. In one of the studies of 124 FHs of school canteens, 80% of them were unable identify any of foodborne pathogens [43]. Contrarily, high level of knowledge about foodborne pathogens was reported [16, 19]. In one of the available studies, it was found that

70-100% of food staff were knowledgeable about most of the foodborne pathogens [19], and in the other study, aspect of the FS related to "foodborne pathogens and related symptoms and illnesses" was scored as one of the highest and was associated with FS training and consistent education [16]. This gives further emphasis for the need of training in this regard. In this regard, FHs must be knowledgeable about certain food materials that are at higher risks for microbial growth such as meat. Safe handling of meat is of a great importance to protect against foodborne diseases. It has been indicated that some natural measures can serve as natural preservative for the meat and fight against microbial proliferation. The use of natural domestic seasoning like "Sumac" is found to be an important strategy to render meat a safer food [44]. Therefore, it is essential to raise awareness among FHs about the updates of FS issues.

In the current study, male gender represented the majority of FHs. The reason behind this finding can be attributed to the fact that, in Jordan, men are more represented in such professions compared to their females counterparts. This is attributed to sociocultural considerations; females often don't contribute in such professions. Male scored higher in their FSK than females, this might be related to the small number of enrolled females in this study. In one of the recent studies of mothers preparing complementary food [45], it was found that the prevalence of good hygienic practice of food preparation was low. Females household activities in Jordan relevant to food handling might be assessed to formulate an understanding about their FSK and the level of food protection at homes.

Regarding the sociodemographics of the FHs, age was associated with FSK. Younger FHs possessed higher FSK than older ones in the current study. While the experience in food handling did not improve the overall FSK assessment outcomes. Consistently, a supportive conclusion was found in one of the studies [46]. This finding emphasizes the notion that adequate FSK can be improved through effective FS training programs and their emerging need. The positive outcomes of the FS training programs have been emphasized by similar studies in different food services (Restaurants and hotels foodservices) in Jordan [16, 27]. However, it has been indicated that food staff who have experience less than 48 months, had significantly lower FSK score than those who have experience that exceeded 48 months [27]. Added to the experience, training may enhance self-confidence of food workers, so they can act in a way to minimize the risk of food contamination.

Hazard Analysis and Control Point (HACCP) implementation in foodservices was reported to be of marked impact upon FSK. Its implementation in the hospital can enhance FS and its knowledge. In the previous study in Jordan, FHs worked in public hospitals and those who believed that HACCP was not important

for FS, had significantly lower FSK scores [27]. Moreover, FHs at food organizations adopting HACCP were found to be of higher FSK levels than those where HACCP is not implemented as its implementation can positively change FSK and practices [42]. The HACCP-based FS system is a standardized framework that can ensure a proper implication of food hygienic practices across the food production phases [47].

FHs with higher educational levels achieved higher knowledge scores. The positive association between the level of education and the FSK was reported in many studies [16, 26, 27, 41]. The higher the level of education the FHs possess, the easier it becomes for them to acquire FSK [48]. For example, FHs with higher educational levels were more knowledgeable in identifying the correct temperature for food handling procedures in one of the studies [49]. However, knowledge levels were significantly greater based on educational levels, there was a low-level of knowledge on some areas of food handling, and there was no significant impact on FSK [46], where, retraining of FHs using different methodologies from the knowledge-based programs was found to be more beneficial [11]. Alongside with educational level, continuous training and updates of knowledge in the FS may improve food protection.

Literature indicated that the reason why only a minority of hospital FHs attended a FS training course maybe attributed to underestimation of the importance of the FS, lack of hospitals' administrative support and commitment to involve them in the FS training sessions [50, 51]. In line with most of the reported conclusions about the importance of FS training [17, 52], findings from the current study supported the premise of this importance. The lack of FS training has been reported to be a reason behind an inadequate FSK, which, in turn, can result in unsafe food handling practices [53, 54]. Studies investigating barriers to FS training are indicated.

## 5. Conclusions

Food handlers of foodservices in hospitals have a low to moderate overall safety knowledge. Further food safety training is needed in certain areas such as food handling operations and pathogens causing foodborne diseases.

## 6. Limitations

A major limitation for this study was the access for the participants to collect data and fear from the threat of COVID-19 virus disease.

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