



Research article

Food safety knowledge, attitudes, and practices among female food handlers engaged in home-based online food businesses in Jordan during the COVID-19 pandemic

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ABSTRACT

Home-based online food businesses have expanded as a result of COVID-19 pandemic restrictions. The objectives of the current study were to identify the knowledge, attitudes, and practices (KAP) among female food handlers who are engaged in home-based online food businesses in Jordan and to investigate the impact of COVID-19 pandemic on food safety measures amongst food providers. The study was a cross-sectional survey. A validated, reliable questionnaire was distributed among female food handlers who are engaged in home-based online food businesses via social media platforms. The researchers also reached out to the participants via cellphone calls. A total of 204 respondents completed the questionnaire. The results revealed that the respondents had low knowledge, negative attitudes, and improper practices toward food safety with a mean score of 22.6 out of 42 points (53.8%). In "personal hygiene" and "cleaning and sanitation" aspects, the respondents showed a high score of KAP ($\geq 60.0\%$). Respondents had low KAP scores ($< 60.0\%$) in the areas of "cross-contamination prevention", "safe storage, thawing, cooking, holding, and reheating of foods", "health problems that would affect food safety", "symptoms of foodborne diseases" and "COVID-19 KAP". There was a significant correlation ($P < 0.05$) between the overall food safety KAP score and both the age of the participant and the impact of COVID-19 pandemic on participants' concerns about food safety. To our knowledge, this is the first study to explore food safety KAP among female food handlers who are engaged in food businesses at homes in Jordan during the COVID-19 pandemic. This study is expected to benefit regulatory authorities establish food safety standards and regulations for home-based food businesses.

1. Introduction

Food contaminated with foodborne pathogens has long been regarded as a threat to global public health due to the illnesses and diseases that can result from its consumption. Food safety is a major concern for consumers, food industries, and regulatory agencies worldwide. According to the World Health Organization (WHO), ingestion of food contaminated by bacteria, viruses, fungi, toxins, or chemicals causes nearly 600 million sicknesses and 420000 deaths worldwide each year (WHO, 2015a). These contaminants find entry into the food system via cross-contamination, contaminated food supplies, improper food handling, inadequate personal hygiene or proliferate within the food due to poor storage conditions, or improper cooking (WHO, 2015b).

Food contamination sources in food production sector could be categorized into: external raw food contamination due to environmental

contamination and transport processes; food conditioning; and food packaging (Nerín et al., 2016; Nida'M & Ahmad, 2010). However, the primary origins of the food safety challenge may be recognized as follows: first, there are ineffective food safety control measures, second, some customers choose to buy foods from traditional sources with a low degree of food safety and third, most people value price and presentation when purchasing food. These factors indicate that customer preferences have nothing to do with food safety (Indrawan et al., 2021; Indrawan et al., 2018). A third of all food produced for human consumption is wasted or thrown away. The economic consequences of food waste are significant, totaling almost USD 1 trillion per year (FAO, 2014). However, contaminated food costs low- and middle-income nations roughly US\$ 110 billion in productivity loss and medical expenditures each year (World Bank, 2018).

Foodborne diseases have the third highest global prevalence in the Eastern Mediterranean region (WHO, 2015a). According to an

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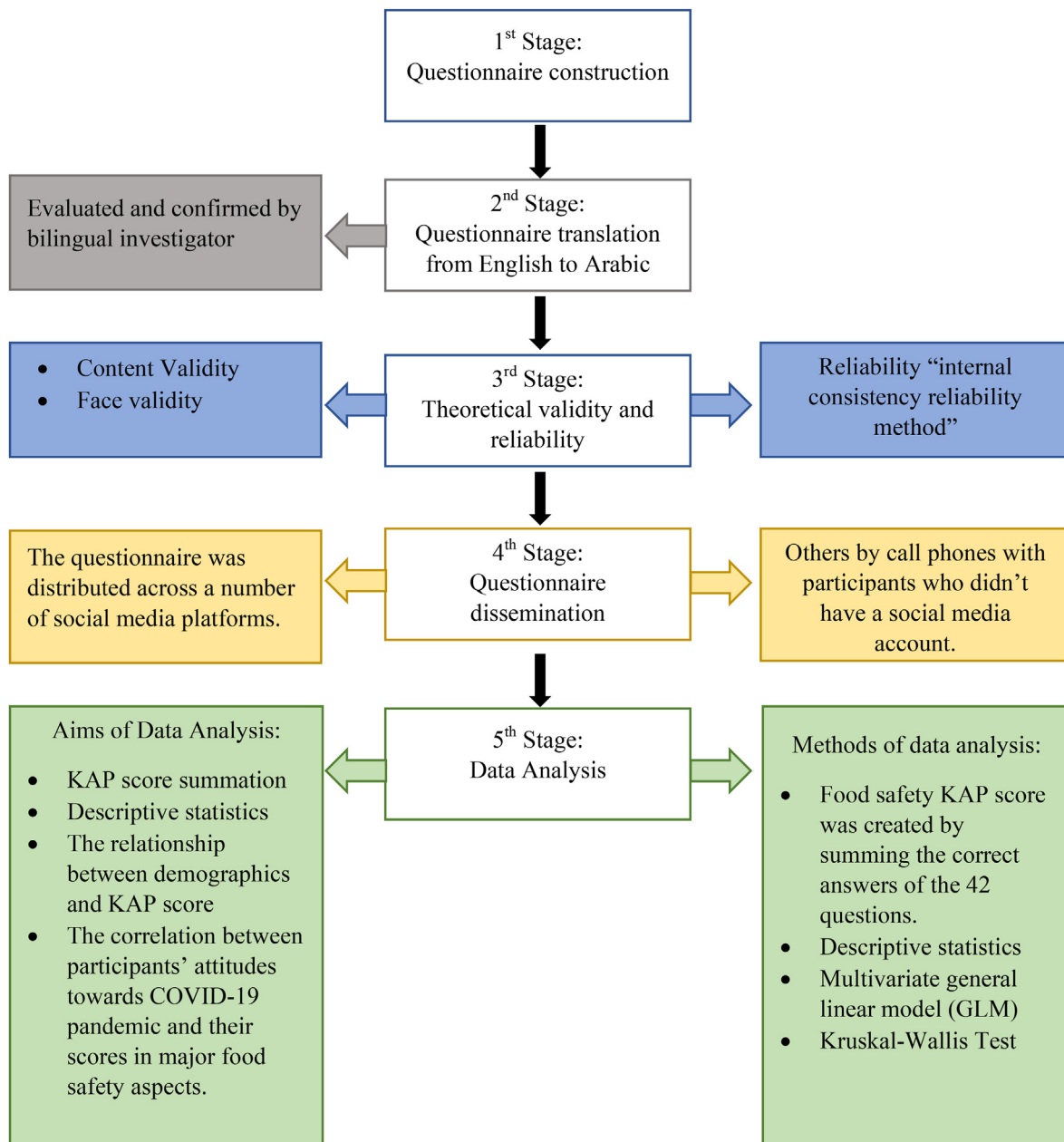


Figure 1. A comprehensive diagram of the study design.

assessment survey conducted by the European Union, 40.5% of foodborne outbreaks originate at home (EFSA & ECDC, 2019). There is a possibility that this number may be even greater as many cases may go unreported (Odeyemi et al., 2019). Poor personal and environmental hygiene are the major contributing factors to home-based outbreaks (Langiano et al., 2012).

Due to a particular set of conditions, food safety risks are higher in Middle Eastern countries. Jordan has passed food laws and set up laboratories to improve government oversight of the food supply. However, food safety remains in doubt and improved epidemiological surveillance systems are needed to improve national prevention and control systems. Jordan was rated 12th out of 15 nations in the Middle East and Africa's global food security index, with a score of 54.2/100 (GFSI, 2019).

Jordan has experienced an influx of refugees in the recent past. Due to the difficult economic conditions facing these refugees, many online home-based foodservice businesses have been started. Jordanian females have further adopted this mode as a source of business. These home-based food businesses serve local markets and school canteens, cater for events,

besides selling food online. To the best of our knowledge, no official statistics exist for the same although the practice is highly prevalent. Moreover, in Jordan, a general trend of higher preference is given to home cooked meals compared to outside catering (Ministry of Health: Hashemite Kingdom of Jordan, 2018). In religious and cultural rituals, food cooked at home is often served to the community and acquaintances.

In a home-based food business, food handling activities such as preparing, holding, processing, packing, wrapping, storing, and transporting occur in the owner's home (FSANZ, 2016). However, the safety of the served food is doubtful. This is because food prepared at home is not regulated by the municipality who periodically assess on-site food outlets for food safety hazards (Izyan et al., 2019). It is due to this reason, that food cooked at home may be susceptible to biological hazards (e.g. bacteria, viruses, and parasites), chemical hazards (e.g. natural toxins and chemical contaminants), and physical hazards (e.g. metal shavings from cans, plastic pieces, or broken glass) (WHO, 2015b).

Jordan's foodborne disease burden is unknown as (to the best of our knowledge) no accurate official records about the number of foodborne

illnesses is present (Osaili et al., 2013). On May 23, 2020, a child died, and another was admitted to the intensive care unit in Jordan due to food poisoning after eating a homemade meal cooked the day before (Al-Tarawneh, 2020). Furthermore, on January 27, 2018, family members in Jordan suffered from food poisoning as a result of consuming a home-cooked shawarma dinner. Three children from the family were sent to intensive care, while seven others were treated and released from the hospital after recovery (Alghad, 2018).

A study conducted by Okour et al. (2020) indicated that Jordanian consumers did not have enough knowledge about grocery buying, food storage and cooking. Many observational studies have shown that food handlers in households have insufficient amount of knowledge regarding food safety (Langiano et al., 2012; Odeyemi et al., 2019; Ruby et al., 2019; Unusan, 2007).

Home-based form of food business existed during the Pre – COVID era in Jordan in an unorganized way and was considered as a shadow economy within the informal private sector (Cook, 2021). However, the COVID-19 pandemic and lockdown altered global food systems and individual consumption patterns, affecting both what and where meals are eaten (Faour-Klingbeil et al., 2021). It was observed that the online food business industry expanded worldwide during the COVID-19 pandemic (Limon, 2021). In Jordan, 72% home-based businesses in the food processing, food preparation, or related industries reported taking steps to prevent the spread of COVID-19 on their premises and implementing business continuity measures (Kebede et al., 2020). Several studies which assess food safety KAP in various industries throughout the world, have indicated that KAP has improved during the COVID-19 pandemic (Dardas et al., 2020; Hatabu et al., 2020; Larisa et al., 2020; Luo et al., 2021; Omar, 2020; Ranaei et al., 2020). However, very limited literature exists regarding the food safety KAP of food handlers engaged in home-based online food businesses (Izyan et al., 2019; Limon, 2021). Because of the escalating growth of home-based online food businesses, they may or may not follow food safety standards (Limon, 2021). In Jordanian society, females are majorly involved in the home – based food business practice. Because lack of food safety knowledge and training was responsible for 80% of hazardous food handling practices, KAP assessment is required to design and deliver appropriate training programs to enhance safe food handling (Lum et al., 2013). Therefore, there is a need to evaluate food safety KAP amongst them.

Therefore, this study aimed to assess the food safety KAP among female food handlers at home based online food businesses during the COVID-19 pandemic in Jordan.

2. Materials and methods

A comprehensive diagram explaining the entire study design can be seen in Figure 1.

2.1. Research hypothesis

During the COVID-19, female food handlers at home based online food business have poor knowledge, negative attitudes, and improper practices on:

- personal hygiene
- cross-contamination prevention
- cleaning and sanitation
- safe storage thawing, cooking, holding, and reheating of foods
- health problems that would affect food safety
- symptoms of foodborne diseases
- COVID-19

2.2. Research design

A cross-sectional study was conducted by disseminating a questionnaire designed to meet the objectives of the study. The study and the

protocol were approved by Institutional Review Board (IRB) at Jordan University of Science and Technology (29/146/2021).

2.3. Participants

Convenience (non-probability) sampling technique was used in this study because the researchers didn't have access to the full target population (not registered in any official records). Any adult female (above the age of 18 years), currently living in Jordan and was involved in a home-based online food business was considered as eligible to participate in the study. A total of 204 female food handlers participated in the study. Because this population is not listed in any official or governmental records, the population number is unknown, hence the sample size could not be accurately determined. The authors stopped sample collection when there was no increase in the samples number for two weeks. All the information deemed necessary about the study was given to the participants, and informed consent was obtained from all of them.

2.4. Questionnaire

The questions were adopted from previously published studies with some modifications (Limon, 2021; Omar, 2020; Osaili et al., 2013). The questionnaire was divided into three sections. The first section included questions about the food handlers' socio-demographic characteristics (age, educational level, marital status, years of experience, and nationality). The second and the third sections dealing with the KAP on food safety and COVID-19 aspects consisted of an overall 42 questions. Main food safety aspects that are associated basically with biological and chemical hazards were tested in the study, these aspects were: personal hygiene (9 questions), cross-contamination prevention (5 questions), cleaning and sanitation (4 questions), safe storage thawing, cooking, holding, and reheating of foods (12 questions), health problems that would affect food safety (3 questions), knowledge of symptoms of foodborne diseases (5 questions) and COVID-19 KAP (4 questions).

2.5. Questionnaire validity and reliability

Step 1. Questionnaire construction. As some questions were adopted from published studies in English, the questionnaire was created in English and then translated into Arabic. Content validity was evaluated and confirmed by a bilingual investigator (Arabic and English).

Step 2. Content validity. Questions were evaluated and assessed by food safety experts and academicians to guarantee content validity based on topic relevancy, clarity, simplicity, and ambiguity, as well as to genuinely measure what was intended to be measured. Moreover, ten participants were selected randomly for face validation of the constructed questionnaire. The questionnaire was self-administered, and participants were asked to keep track of how long it took them to complete it, the clarity of the content, and the language and vocabulary used. Their opinions on the questionnaire's instructions and content were evaluated and discussed by the food safety experts and academicians. Minor corrections were made in response to their comments and recommendations. The questions were multiple choice and Likert scale based. It took 15–20 min to complete the questionnaire.

Step 3. The reliability of the questionnaire. A pilot study was performed on 30 females to measure the reliability. The degree to which the food safety KAP test is consistent in measuring what it is intended to measure, was measured using the internal consistency reliability method. The questionnaire was considered reliable with a Cronbach's Alpha of 0.71.

2.6. Questionnaire dissemination and response bias

To avoid bias and ensure that everyone had an equal chance of receiving the survey invitation, the questionnaire was distributed across

Table 1. Characteristics of the female food handlers engaged in home-based online food businesses in Jordan (n = 204).

Characteristics of the survey respondents	Frequency (n)	Percent (%)
Age	≤24	15.7
	25–44	57.4
	≥45	27.0
Educational Level	Illiterate or School education (≤12 years)	22.1
	College education (Diploma)	18.1
	University education	46.6
	Higher education	13.2
Marital Status	Single	39.2
	Married	60.8
Experience	<5	19.1
	5–10	49.5
	>10	31.4
Nationality	Jordanian	97.5
	Other	2.5
Food Safety Information Source	Doctor	6.9
	Nutritionist	35.8
	Internet	50.5
	Health care givers	12.7
	Family and friends	24.5
	Television	23.5
	Major of study	22.5
	Food Safety Courses	21.1
	Other	5.9
Did the COVID-19 pandemic increase your concern on food safety?	Yes	76.5
	Neutral	13.2
	No	10.3

a number of social media platforms (Facebook, WhatsApp). The social media platforms were searched for groups in Jordan which specialize in cooking that included females. After the identification of the appropriate groups, an invitation and the questionnaire was posted on these groups. Moreover, WhatsApp was also used to disseminate the questionnaire. Encouragement of the circulation of the questionnaire to anyone meeting the criteria was written as part of the message. Because not everyone has a social media account to respond to online surveys, the researchers reached out to the participants who met the inclusion criteria via cell-phone calls. Their responses were recorded by the researchers. Care was taken to not influence the responses in any form. Their phone numbers were obtained through their personally promoted brochures, posters and newspaper advertisements. Other phone numbers were obtained from friends and relatives with first-hand experience with some home-based food business. The researchers made the survey anonymous and composed the questionnaire of neutrally worded questions. Care was taken to not include any leading question and answer choices.

2.7. Data analysis

Each respondent's overall food safety KAP score was created by summing the correct answers of the 42 questions. Each correct answer was given one point, while wrong answers did not get any score. The IBM SPSS Statistical Package for Social Sciences was used to analyze the data (IBM Corp., Armonk, N.Y., USA). Means, standard errors, frequencies, and percentages were calculated based on the type of variable. The relationship between respondents' general characteristics and their total food safety KAP score was investigated using a multivariate general linear model (GLM). GLM is a special case of the generalized linear model, in which variables follow a conditionally normal distribution. It is

Table 2. Food safety KAP score (Mean and Percentage) of female food handlers who are engaged in home-based food businesses in Jordan (n = 204).

Aspect	Score Mean ± Std. Error	Score percent ¹ ± Std. Error
Total food safety knowledge, attitudes, and practices ²	22.6 ± 0.3	53.7 ± 0.7
Personal hygiene ³	6.9 ± 0.1	76.8 ± 1.1
Food-contamination prevention ⁴	2.2 ± 0.1	43.0 ± 1.9
Cleaning and sanitation ⁵	2.4 ± 0.1	60.0 ± 1.5
Safe storage, thawing, cooking, holding and reheating of foods ⁶	5.1 ± 0.2	42.2 ± 1.2
Health problems that would affect food safety ⁷	1.2 ± 0.1	40.7 ± 2.0
knowledge of symptoms of foodborne diseases ⁸	2.5 ± 0.1	49.0 ± 1.6
COVID-19 ⁹	2.4 ± 0.1	59.1 ± 1.5

¹ Score percent = (Score/maximum*100).

² 42 questions.

³ 9 questions.

⁴ 5 questions.

⁵ 4 questions.

⁶ 12 questions.

⁷ 3 questions.

⁸ 5 questions.

⁹ 4 questions.

used to relate some number of continuous and categorical predictors to a single outcome variable. In our study, multivariate GLM was used to determine whether the means of two or more groups of independent variables (demographics) differ in relation to the dependent variable (total food safety KAP score). However, GLM is not useful with variables which do not follow normal distribution. Therefore, a nonparametric test (a distribution-free test) was used with these variables. The Kruskal-Wallis test (nonparametric test) was used to determine the correlation between the impact of COVID-19 pandemic on respondents' food safety concerns and their overall food safety KAP score. Moreover, Kruskal-Wallis Test was carried out to identify the correlation between participants' attitudes towards COVID-19 pandemic and their scores in major food safety aspects.

The overall KAP scores of the respondents were split into two groups. Respondents with a total KAP score of 60% or above were considered to have high knowledge, positive attitudes, and proper practices, while those below 60% were considered to have low levels of knowledge, negative attitudes, and improper practices. The cut-off value (60%) was adopted from a study conducted by Ayaz et al. (2018) to evaluate food safety KAP among Saudi mothers.

3. Results and discussion

3.1. Characteristics of the survey respondents

A total of 204 respondents (97.5% Jordanian and 2.5% other nationalities) from various regions of Jordan participated in the study (Table 1). Less than a quarter (15.7%) of the respondents were under the age of 24. About 57.4% and 27% of the respondents were between the age groups of 25 and 44 years and ≥45 years, respectively. The majority were married (60.8%) while 39.9% were single. With respect to the educational level, about 13.2, 18.1, 22.1, and 46.6% of the respondents had a higher education degree (MSc or PhD), college education (Diploma), were illiterate or had a school education (≤12 years), and university education degree, respectively. About 19% of the respondents had an experience in food business of less than five years, 49.5% had an experience between five and ten years, and 31.4% had an experience of more than ten years. About 76.5% of the respondents indicated that the COVID-19 pandemic increased their concern about food safety.

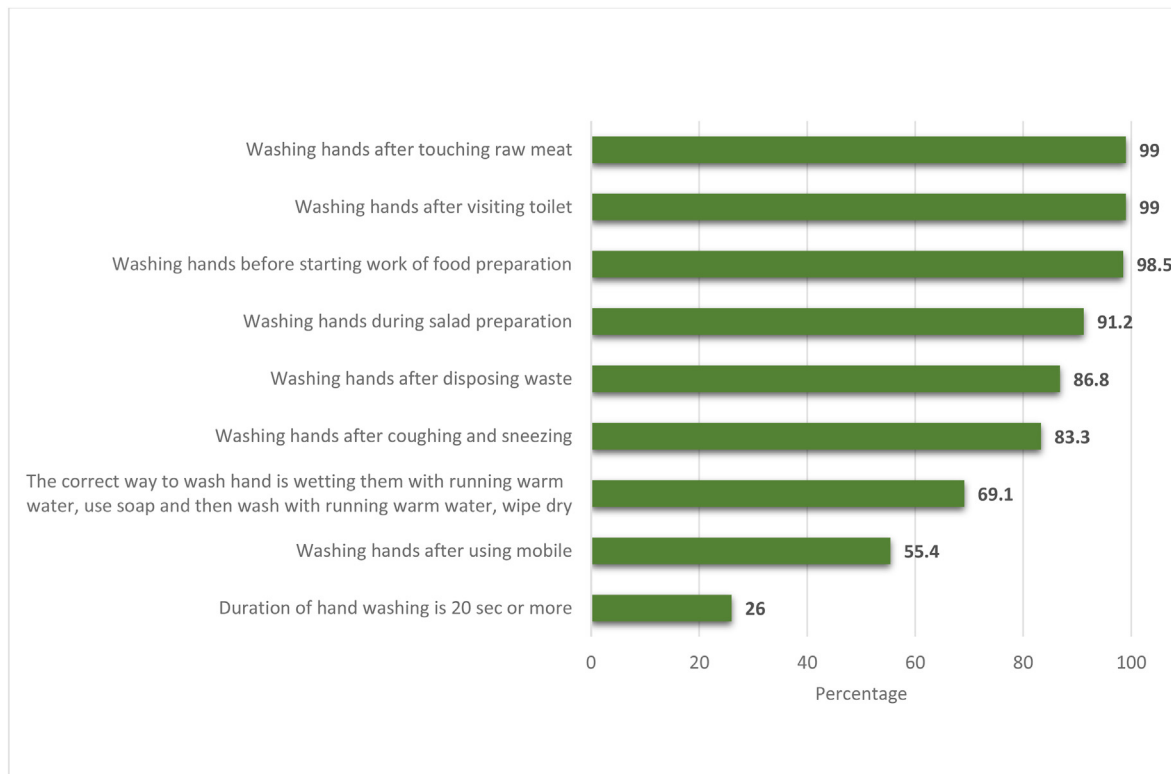


Figure 2. Percentage of correct responses for the “personal hygiene” aspect (n = 204).

3.2. Total food safety KAP

The results provide important information about food safety KAP among female food handlers who were engaged in home-based food businesses during the COVID-19 pandemic in Jordan. The total food safety KAP scores are represented in Table 2. The minimum total food safety KAP score of the tested aspects was 12 and the maximum was 36 (out of 42). The survey revealed low knowledge as well as negative attitudes and improper practices regarding food safety with a mean score of 22.6 out of 42 points, corresponding to 53.7% of the questions being answered correctly. Similar results were revealed by Limon (2021), who

reported insufficient knowledge and improper practices among food handlers engaged in home-based food businesses during COVID-19 in the Philippines. These findings are also supported by those of Gong et al. (2016), Jevšnik et al. (2008) and Langiano et al. (2012). In contrast, the majority of food handlers engaged in home-based online food businesses in Malaysia had high food safety knowledge (Izyan et al., 2019).

3.2.1. “Personal hygiene” aspect

The mean knowledge and practices score percent of the personal hygiene aspect recorded in our study (76.8 %) is the highest score among the other aspects. This is higher than the 46.2% reported among domestic

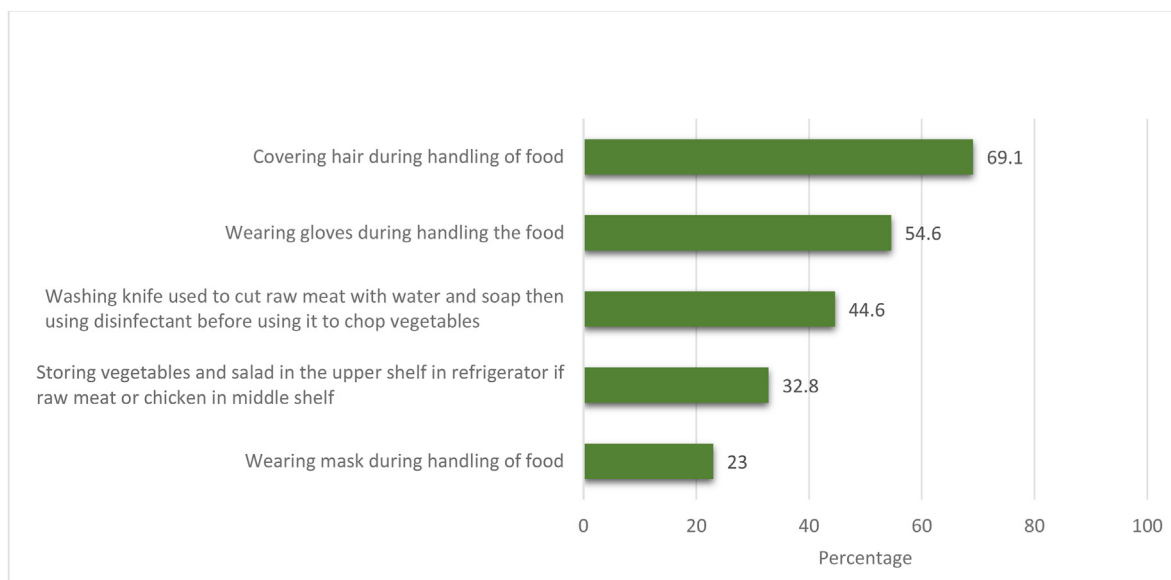


Figure 3. Percentage of correct responses for the “cross-contamination prevention” aspect (n = 204).

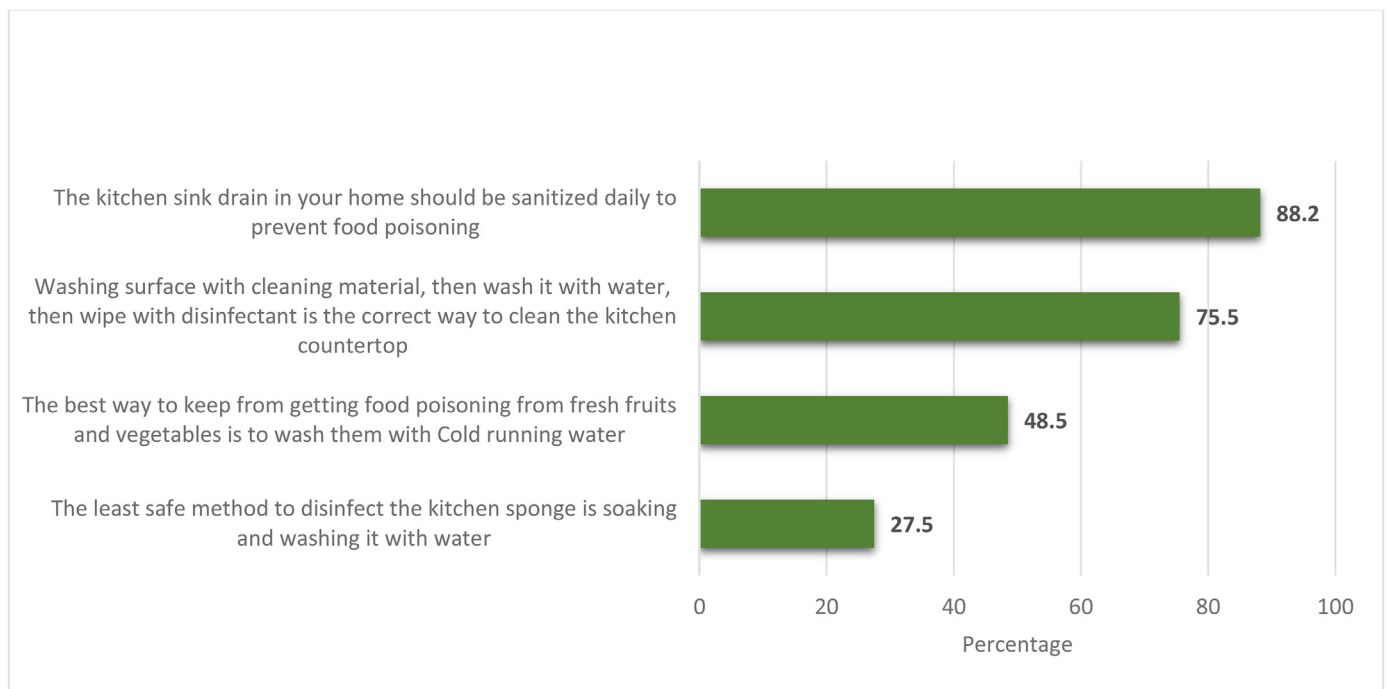


Figure 4. Percentage of correct responses for the “cleaning and sanitation” aspect (n = 204).

workers in the UAE (Osaili et al., 2021) and 41.7% reported among operators of food businesses in the Philippines (Limon, 2021). This shows that the females in our study gave importance to personal hygiene during food preparation. A study conducted by Adane et al. (2018) reported that food handlers in Ethiopia prioritized personal hygiene while preparing food at home. In this study, more than 91% of the participants were able to identify four occasions where hand washing should be performed prior to handling food (Figure 2). This is better than that reported by Limon (2021). About 87, 83 and 55% of the respondents stated that they wash their hands after disposing of waste, coughing and sneezing, and after using mobile phones. Although 69.1% of the females stated that they knew the correct way to wash hands, only 26% of them knew that the duration of hand washing is 20 s or more. Hand washing for at least 20 s is a critical practice in food preparation to prevent cross-contamination, according to CDC guidelines (CDC, 2018b). Personal hygiene is a must for those who are engaged in an online food business to prevent contamination of the food they prepare for their customers. Foodborne disease is exacerbated by poor personal hygiene (Carstens et al., 2019), and the effects can be fatal for consumers (WHO, 2015b).

3.2.2. “Cross-contamination prevention” aspect

The females in our study had low knowledge, negative attitudes, and improper practices about cross contamination with a score percent mean of 43% (Figure 3). This is concerning because the repercussions might be fatal especially for the immunocompromised population like children, pregnant women and patients. The majority of foodborne disease outbreaks in households are associated with cross-contamination (Redmond and Griffith, 2003). Our finding in the current study is comparable to that reported among food handlers in the Philippines (26%) (Limon, 2021). Less than half (44.6%) of the respondents answered the question about the means for preventing cross-contamination between foods (by washing and disinfecting the knife used to cut raw meat and chop vegetables) correctly. In comparison, a study conducted by Nesbitt et al. (2009), 64.7% of the respondents answered the same question correctly. Moreover, in the current study, a low percent of respondents (32.8%) stored vegetables and salads in the upper shelf of the refrigerator if raw meat or chicken was in the middle shelf. In comparison, higher percentages were reported in Sharjah, United Arab Emirates (70.1%) (Saeed

et al., 2021) and Malaysia (82.9%) (Izyan et al., 2019). About 70% of the respondents in our study stated that they cover their hair during food handling. Encouraging results regarding wearing gloves during food handling (45.6%) were also observed in our study. This is better than that reported among food handlers in Sohag Governorate, Egypt (18.6%) (Hamed and Mohammed, 2020). Lastly, only 23% of females in our study wore masks during the handling of food. When food handlers do not use protective masks when preparing food, nasal droplets as a result of sneezing or coughing may contaminate the food (CDC, 2020). The results overall indicate the need for training about food safety skills among food handlers who are engaged in home-based online food businesses (Al-Kandari and Jukes, 2009).

3.2.3. “Cleaning and sanitation” aspect

High knowledge and proper practices regarding cleaning and sanitation were observed in our study with a score percent mean of 60%. The percentage of respondents who knew the appropriate procedure for cleaning and sanitizing the kitchen countertop (75.5%) was higher than that of consumers in Slovenia (59.7%) (Jevšnik et al., 2008). Considering that the kitchen sink must be cleaned daily to prevent food poisoning (Okpala and Ifeoma, 2019), 88.2 % of the respondents in the current study sanitized the kitchen sink daily (Figure 4). This finding was better than that stated by females in Lahore (82.1%) (Naeem et al., 2018). On the other hand, 95.9% of the females in Lahore knew that washing raw fruits and vegetables in cold running water makes them safe to eat (Naeem et al., 2018), while in the current study, only 48.5% were aware about the practice. Several studies have considered kitchen sponges as a crucial reservoir of food pathogens that can contaminate food (Osaili et al., 2021; Sharma et al., 2009). Only 27.5% of the females in our study knew that soaking and washing the kitchen sponge with water was the least safe procedure to disinfect it.

3.2.4. “Safe storage, thawing, cooking, holding and reheating of foods” aspect

Time-temperature abuse is considered the most leading cause of foodborne diseases. The females in our study had low knowledge, negative attitudes, and improper practices regarding temperature control of food with a mean score percent of 42.2%. The responses with the

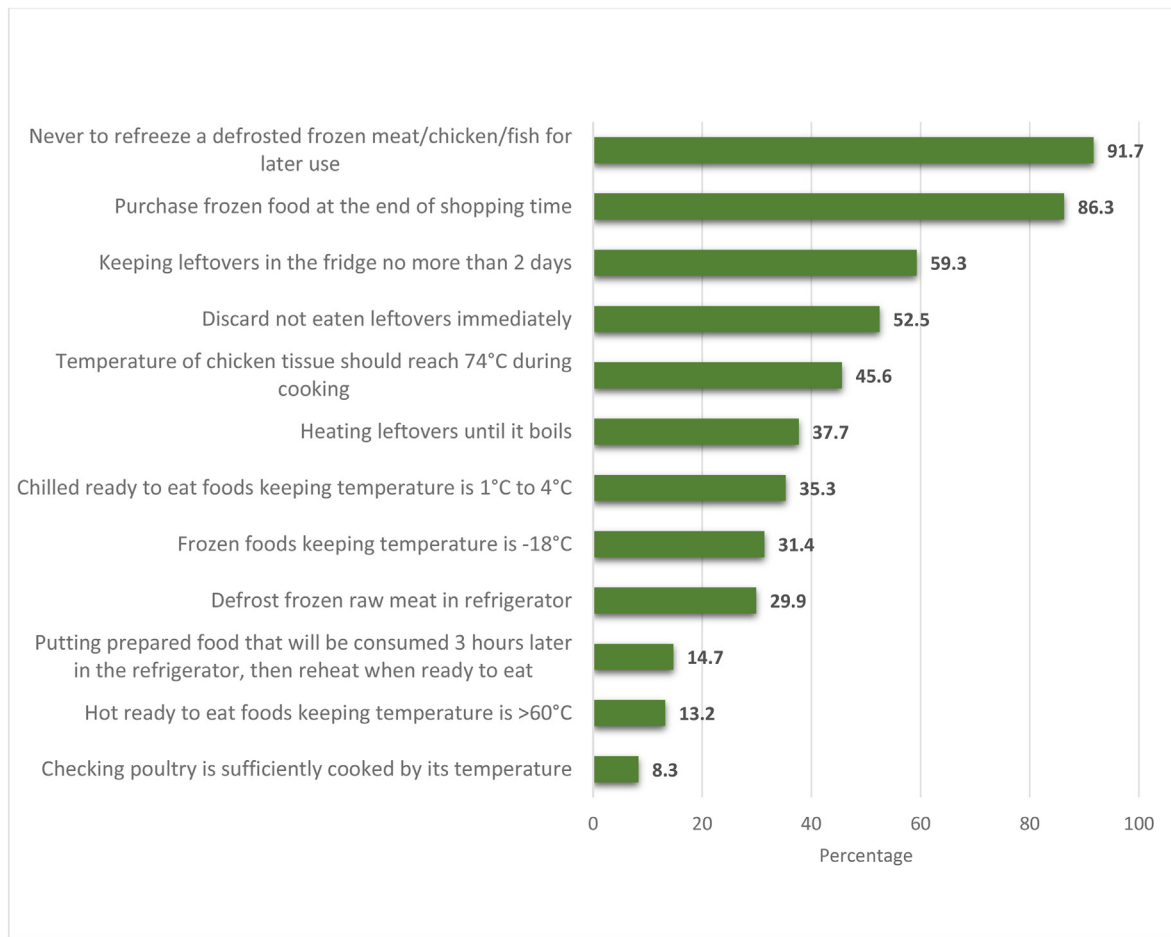


Figure 5. Percentage of correct responses regarding safe storage, thawing, cooking, holding and reheating of food (n = 204).

highest percentage of correct responses were about never refreezing defrosted frozen meat, chicken, or fish for later use (91.7%) and purchasing frozen food at the end of the shopping trip (86.3%), respectively (Figure 5). In comparison, 75% of home-based food providers in Malaysia were found to be aware that they should not refreeze defrosted food

(Izyan et al., 2019). As for the leftovers, 59.3 % of females answered correctly about keeping leftovers in the fridge for no more than 2 days. Only 37.7% of the household females heated leftovers until boiling, and 52.5% discarded not-eaten leftovers immediately. According to the USDA Food Safety and Inspection Service, leftovers should be handled

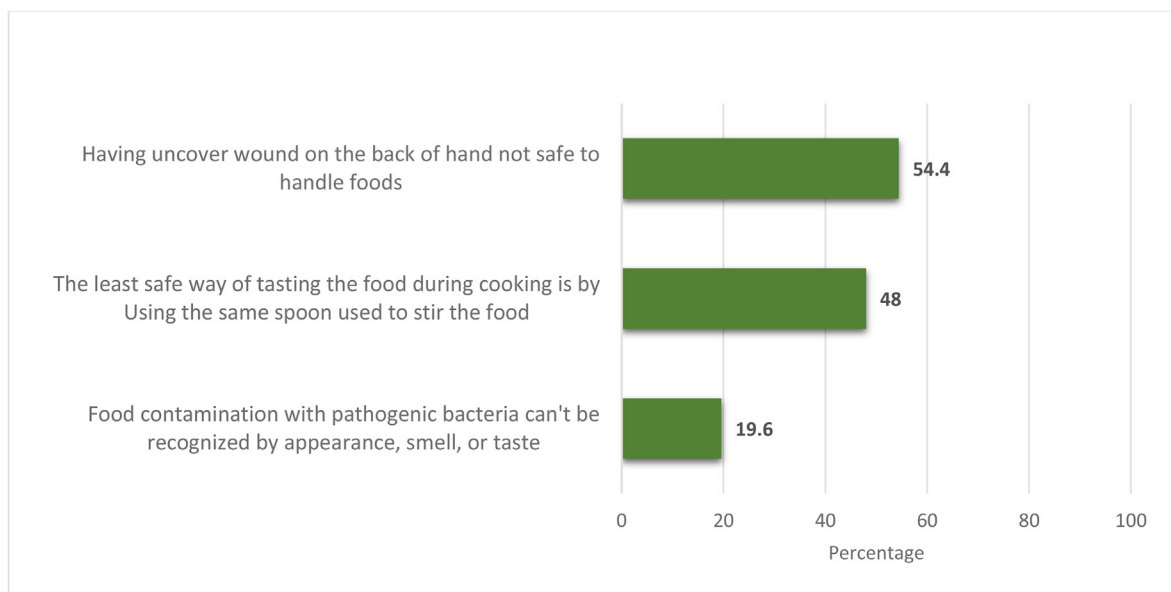


Figure 6. Percentage of correct responses for “health problems that would affect food safety” aspect (n = 204).

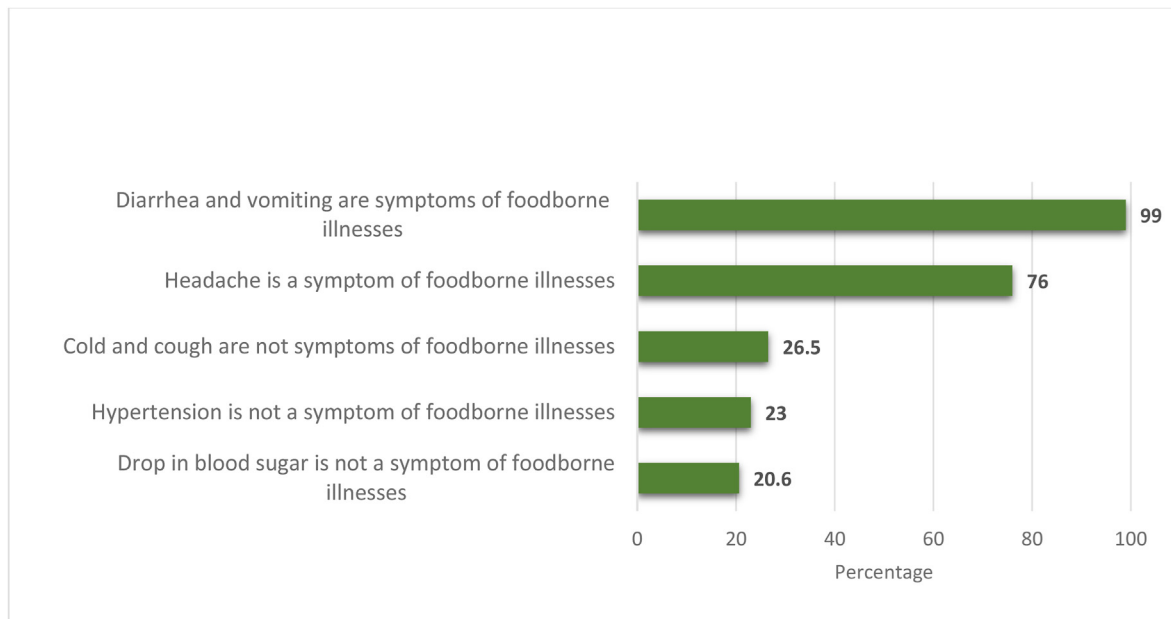


Figure 7. Percentage of correct responses about the “knowledge of symptoms of foodborne diseases” (n = 204).

hygienically and stored in sealable clean dishes which are kept out of the temperature danger zone. Ideally, leftovers should be stored between 4-7 °C in the refrigerator for no more than three days. If longer, the leftovers should be frozen (USDA, 2020). About 30% of the respondents in this study defrosted raw meat in the refrigerator. In comparison, a better percentage was obtained amongst females in Lahore (90.7%) (Naeem et al., 2018). A very low knowledge level was observed regarding the use of a thermometer to check sufficient cooking of poultry (8.3%). This is similar to 3.3% reported in the Philippines by Limon (2021). Low knowledge about food keeping temperatures was also observed with 35.3, 31.4, 13.2, and 45.6% of the respondents knowing that chilled ready-to-eat food should be kept at 1–4 °C, frozen food should be kept at -18 °C, hot ready-to-eat food would be kept at >60 °C, and the temperature of chicken tissue should reach 74 °C during cooking, respectively. Likewise, a study conducted in the north of Jordan among university female students, obtained similar results regarding food keeping temperatures (Osaili et al., 2011). Lastly, only 14.7% of the respondents

knew that prepared food that will not be consumed within 3 h must be kept in the refrigerator, and reheated when ready to eat. According to the WHO (2017), the abuse of time-and-temperature during food preparation, holding, and storage leads to foodborne diseases. This demonstrates that females in our study did not sufficiently follow the international food safety recommendations. Finally, food control and biosecurity policies are crucial to controlling zoonotic diseases and emerging viruses in the global value chain, notably the food chain, to protect public health, according to a detailed examination of the balance between food providers and consumer protection (Indrawan & Daryanto, 2020).

3.2.5. “Health problems that would affect food safety” aspect

The lowest knowledge and the most negative attitudes observed in our study was about the aspect of health problems that would affect food safety with a mean score percent of 40.7%. More than half (54.4%) of the respondents in our study believed that it was not safe to handle foods with an uncovered wound on the back of their hand, which is better

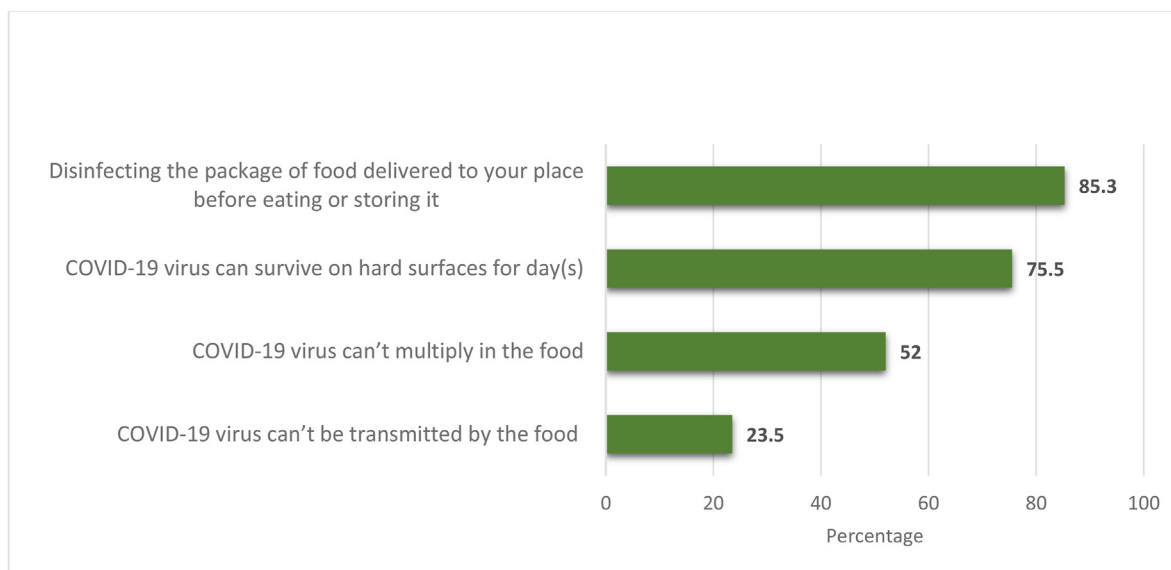


Figure 8. Percentage of correct responses for the “COVID-19 KAP” aspect (n = 204).

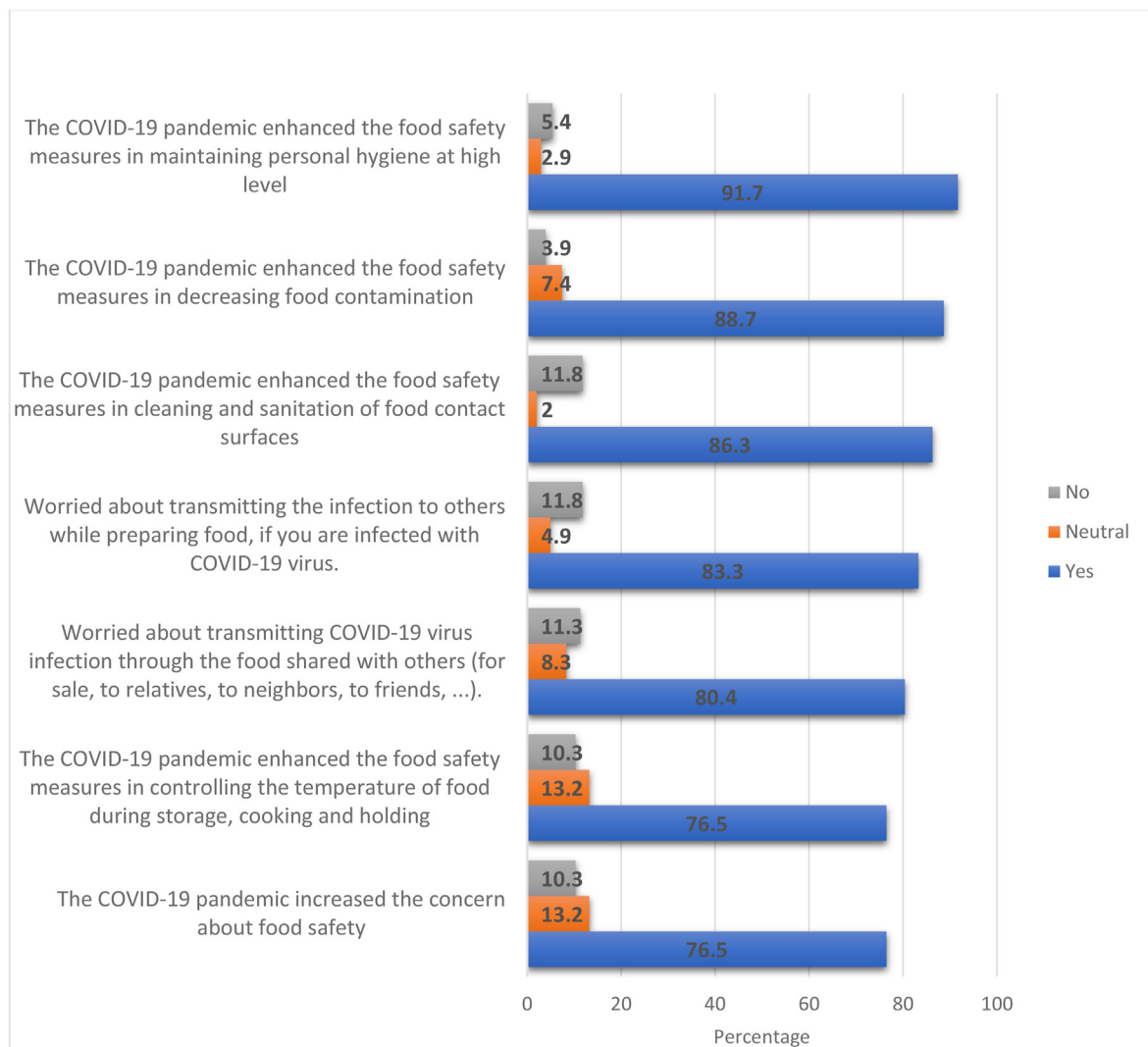


Figure 9. Respondent views regarding the enhancement of food safety measures during COVID-19 in Jordan (n = 204).

than that reported in China (25.5%) (Gong et al., 2016), in Brazil (29.1%) (Uggioni and Salay, 2012), and in Greece (19.6%) (Lazou et al., 2012). Pathogen contaminated food items may not smell, taste or even look different (CDC, 2018a). Only 19.6% of the females in our study were aware about this fact. Less than half of the female respondents in our study knew that it was not safe to taste food with same spoon used to stir the food (Figure 6). Such KAP of home-based online food businesses are concerning with regards to food safety.

3.2.6. "Knowledge of symptoms of foodborne diseases" aspect

Regarding symptoms of foodborne diseases, home-based food providers in the current study had low knowledge. More than three quarters (76 %) of the respondents answered that headache is a symptom of foodborne illnesses (Figure 7). Only 23, 20.6 and 26.5% of the respondents knew that a drop in blood sugar, hypertension, and cough and cold are not symptoms of foodborne illnesses. Nevertheless, the majority of them (99%) recognized vomiting and diarrhea as symptoms of a foodborne disease. This could be because diarrhea and vomiting are the most commonly reported manifestations of foodborne disease in the media. In contrast, 80% of female in Sharjah-United Arab Emirate (Saeed et al., 2021), 97% of females who stay at home in Turkey (Unusan, 2007), and 85% of participants in Portugal (Carbas et al., 2013) possessed knowledge about the symptoms of foodborne diseases.

3.2.7. "COVID-19 KAP" aspect

Although 85.3% of the respondents disinfected food packages before eating or storing them; overall, they had relatively low knowledge, negative attitudes, and improper practices regarding COVID-19 with a score percent mean of 59.1%. Only 52 and 23.5% of the respondents reported they knew that COVID-19 virus can't multiply in food or be transmitted by it, respectively. About 75 % of the female in our study believed that the COVID-19 virus could survive on hard surfaces for day(s) (Figure 8). WHO (2020) stated that COVID-19 cannot multiply in food or be transmitted by food itself, but due to virus survival on surfaces, it may be a route of spreading the disease. There is a need to educate the operators of home-based food businesses about food safety during serious public health circumstances, such as COVID-19 (Tarver, 2020).

3.3. Enhancement of participants' food safety measures during COVID-19

A good 76.5% of females reported COVID-19 pandemic raised their concerns about food safety. Also, 80.4 and 83.3% of the respondents reported they were worried about transmitting COVID-19 virus infection through the food that they shared with others, and that they were worried about transmitting the infection to others while preparing food if they were infected with COVID-19, respectively. In a similar study, 90% of respondents in a study conducted in Brazil, stated that they are more careful about food hygiene practices and perceptions because of their

Table 3. Associations between food safety KAP score and general characteristics of females engaged in home-based food businesses in Jordan (n = 204).

Characteristics of the survey respondents	Score Mean \pm Std. Error	Score percent ¹ Mean \pm Std. Error	p value
Age²			
≤ 24	21.94 ^{ab} \pm 0.9	52.2 \pm 2.09	0.01
25–44	23.33 ^a \pm 0.4	55.6 \pm 0.85	
≥ 45	21.25 ^b \pm 0.6	50.6 \pm 1.5	
Educational Level²			
Illiterate or School education (≤ 12 years)	21.60 \pm 0.7	51.4 \pm 1.6	0.17
College education (Diploma)	23.19 \pm 0.8	55.2 \pm 1.8	
University education	22.42 \pm 0.4	53.4 \pm 1.0	
Higher education	23.74 \pm 0.8	56.5 \pm 2.0	
Marital Status²			
Single	22.2 \pm 0.5	52.9 \pm 1.2	0.39
Married	22.8 \pm 0.4	54.2 \pm 0.9	
Experience²			
< 5	21.5 \pm 0.6	51.2 \pm 1.5	0.11
5–10	23.1 \pm 0.5	55.1 \pm 1.1	
> 10	22.3 \pm 0.5	53.0 \pm 1.2	
Did the COVID-19 pandemic increase your concern on food safety?³			
Yes	23.0 ^a \pm 0.3	54.7 \pm 0.8	0.02
Neutral	20.5 ^b \pm 0.7	48.9 \pm 1.7	
No	22.0 ^{ab} \pm 1.1	52.5 \pm 2.7	

Note: means with different letters in the same columns are significantly different at $P < 0.05$. All variables were adjusted for each other.

¹ Score percent = (Score/maximum*100).

² A multivariate general linear model (GLM) was used.

³ Kruskal-Wallis Test was used.

belief that food can transmit the COVID-19 virus (Rodrigues et al., 2021). Furthermore, 88.7, 91.7, 76.5, and 86.3% of the respondents in our study indicated that the COVID-19 pandemic enhanced their food safety measures by practices of decreasing food contamination, maintaining personal hygiene at a high level, controlling the temperature of food, and

cleaning and sanitation of food contact surfaces, respectively (Figure 9). Similar finding was reported in Brazil where about 72% of the respondents wanted to learn about cleaning and sanitation of food contact surfaces (Rodrigues et al., 2021).

3.4. Association between food safety KAP scores and general characteristics of respondents

There were no significant association between food safety KAP score and educational level, marital status, or experience (Table 3). However, a significant association between female's food safety KAP scores and age and the impact of the COVID-19 pandemic on their food safety concerns were observed in this study ($P < 0.05$). Females within the age group of 25–44 years had significantly higher food safety KAP compared to other age categories. Similar to the finding of the current study, several studies have reported that food safety knowledge increases with age (Carbas et al., 2013; Limon, 2021; Rimal et al., 2001; Unusan, 2007; Wang et al., 2009). One study indicated that middle aged participants although had high knowledge, it did not translate to better practice (Kasemy et al., 2020). Respondents who stated that the COVID-19 pandemic increased their concern about food safety had significantly higher food safety KAP scores than those who were neutral about it. A study conducted in China reported that residents who focused on COVID-19 pandemic-related information had significantly higher food safety knowledge and followed recommended practices (Shi et al., 2020).

3.5. The correlation of major food safety aspects scores and the enhancement of participants' food safety measures during COVID-19

During the COVID-19 pandemic, there has been a surge in demand for cleaning, hygiene, and online ordering of food supplies (Akgün and Zer-enler, 2021). There were no significant associations between the “food contamination prevention” and “safe storage, thawing, cooking, holding, and reheating of food” aspects scores and “respondents' attitudes about the impact of the COVID-19 pandemic on their food safety measures” in decreasing food contamination and “controlling the temperature of food during storage, cooking and holding” (Table 4). However, a significant association was observed between “personal hygiene” aspect score and

Table 4. Correlation of major food safety aspects scores and the enhancement of food safety measures during COVID-19 in Jordanian food handlers engaged in home-based food businesses (n = 204).

Aspect	COVID-19 question	Score Mean \pm Std. Error	Score percent ¹ Mean \pm Std. Error	p value
Food contamination prevention	The COVID-19 pandemic enhanced your food safety measures in decreasing food contamination			0.18
	Yes	3.4 \pm 0.8	37.5 \pm 8.9	
	Neutral	4.6 \pm 0.1	51.4 \pm 1.4	
Personal Hygiene	The COVID-19 pandemic enhanced your food safety measures in maintaining your personal hygiene at high level			0.04
	Yes	7.0 ^a \pm 0.1	78.0 \pm 1.0	
	Neutral	6.0 ^{ab} \pm 1.0	66.7 \pm 10.7	
Cleaning and sanitation	The COVID-19 pandemic enhanced your food safety measures in cleaning and sanitation of food contact surfaces			0.02
	Yes	2.4 ^a \pm 0.1	60.9 \pm 1.7	
	Neutral	2.5 ^a \pm 0.3	62.5 \pm 7.2	
Safe storage, thawing, cooking, holding and reheating of foods	The COVID-19 pandemic enhanced your food safety measures in controlling the temperature of food during storage, cooking and holding			0.14
	Yes	4.9 \pm 0.1	40.5 \pm 1.2	
	Neutral	5.8 \pm 0.5	48.1 \pm 4.5	
	No	5.6 \pm 0.5	46.8 \pm 4.2	

Note: means with different letters in the same columns are significantly different at $P < 0.05$. Kruskal-Wallis Test was used. All variables were adjusted for each other.

¹ Score percent = (Score/maximum*100).

respondents' attitudes about the impact of the COVID-19 pandemic on their food safety measures in maintaining their personal hygiene at a high level ($P < 0.05$). Respondents who believed that the COVID-19 pandemic enhanced their food safety measures to maintain their personal hygiene at a high level had a significantly higher personal hygiene aspect score. Moreover, significant associations between "cleaning and sanitation" aspect score and respondents' attitudes about the impact of the COVID-19 pandemic on their food safety measures in cleaning and sanitation of food contact surfaces was observed ($P < 0.05$). Females who believed that the COVID-19 pandemic did not enhance their food safety measures in cleaning and sanitation of food contact surfaces had a significantly lower "cleaning and sanitation" aspect score than those who believed that the COVID-19 pandemic enhanced it. Similar to our study, Faour-Klingbeil et al. (2021) reported the COVID-19 pandemic significantly affected consumers' food safety in many aspects, such as food purchasing, food handling, and hygiene practices in Lebanon, Jordan, and Tunisia. Similarly, a study conducted by Thomas and Feng (2021) in the United States, reported that the COVID-19 pandemic had an impact on food handlers' food safety practices. Practices such as an increase in hand washing, washing fruits and vegetables with water, and using a food thermometer were being observed. But because of the spread of incorrect information, inappropriate practices such as washing fruits and vegetables with soap were also being practiced. As in the case of any public health concern, it is important to address misleading or inaccurate information.

4. Conclusion

The current study concluded that female food handlers who are engaged in home-based food businesses in Jordan had low knowledge, negative attitudes, and improper practices regarding food safety during the COVID-19 pandemic. To improve the overall food safety KAP attributes, regulatory authorities should pay attention to those who manage home-based food businesses and establish food safety standards and regulations for these strata in Jordan. Only licensed establishments should be given the permission to operate. Various food safety training programs should be conducted to prevent foodborne outbreaks and food safety threats. Training programs cover main proper food handling and food safety aspects should be implemented as a requirement of getting the license. Finally, rather than self-reported studies, future research should involve the observation of actual practices of food handlers engaged in home-based food businesses.

5. Limitations

The study's limitations include the primary focus on self-reported food safety procedures, which are prone to respondent bias. Moreover, the demographic section did not cover all societal variables that may influence food safety KAP, such as income, household size, and occupation. Lastly, home-based food providers are not registered with any official or governmental authorities in Jordan, and no records determine the number of this population. This created a hindrance in the calculation of a sample size.

6. Major contribution

The results of this study could help the relevant food control authorities better understand the KAP of female food handlers who are engaged in online home-based food business in Jordan. This would help them develop educational programs and materials to educate this strata of food handlers.

Declarations

Author contribution statement

Tareq M. Osaili: Conceived and designed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Anas A. Al-Nabulsi: Conceived and designed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Tasneem M. Al-Jaberi: Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

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Data availability statement

The data that has been used is confidential.

Declaration of interest's statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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