

Food safety and personal hygiene knowledge, attitudes, and practices of Jordanian mothers in the face of the COVID-19 pandemic: A cross-sectional survey

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Abstract

Background and Aim: Foodborne illnesses have shaken mothers' defense worldwide because poor knowledge and unsafe food handling practices can jeopardize their children. In Jordan, there are no reliable data on the knowledge, attitudes, and practices (KAPs) of mothers regarding food safety when the COVID-19 pandemic occurs. Therefore, this study evaluated Jordanian mothers' understanding, beliefs, and behaviors by examining their KAPs during the COVID-19 pandemic crisis.

Materials and Methods: We conducted a cross-sectional study on food safety KAPs of mothers living in Jordan following the COVID-19 pandemic. A reliable and accurate survey with 55 questions was distributed among mothers through social media. A total of 376 mothers completed the questionnaire.

Results: The results showed a remarkable awareness among the participants of how to keep food safe. However, there is still a significant gap in the implementation of this information in everyday life. This research emphasizes the need for focused interventions in the context of COVID-19 to bridge the gap between Jordanian mothers' KAPs on food safety and personal cleanliness.

Conclusion: Efforts should be made, such as public health campaigns and educational programs, to empower mothers, guaranteeing a consistent and comprehensive approach to food safety and personal hygiene in families. These results provide important insights for policymakers and health professionals who want to improve public health initiatives and community resilience during public health crises.

Keywords: food safety, foodborne illness, Jordan, knowledge, attitudes and practices, personal hygiene.

Introduction

Severe Acute Respiratory Syndrome coronavirus 2 (SARS-CoV-2) was first detected in December 2019 among residents living in Wuhan, Hubei, China, who have a typical ability to rapidly get viral [1]. After its emergence, this contagion spread globally rapidly [2]. The World Health Organization (WHO) officially classified the infectious disease COVID-19 as a pandemic in March 2020 [3]. Many countries have taken stringent measures to stop the transmission of viruses, such as home reservations, social isolation, temporary closures of businesses, schools, and universities, and remote work arrangements [4].

In the Eastern Mediterranean region, Jordan has an approximate population of 10.6 million residents

and a total land area of 89,342 km² [5]. In response to the outbreak of COVID-19, the Jordanian government issued a state of emergency on March 17, 2020, which included a number of measures aimed at curtailing the transmission of the virus, calling for social distancing and a lockdown on all border arrivals from pandemic countries before that date [5].

Foodborne infections are a significant public health issue and an economic burden for nations [6, 7]. It is caused by contaminated food and beverages due to poor sanitation or preparation [8]. Few studies have indicated the transmission of COVID-19 through food products or packaging [9]. Nevertheless, it is crucial to acknowledge that coronavirus can remain viable for prolonged durations in environmental specimens, which could potentially heighten the chances of transmission through contact with the surfaces of packages [10]. On the other hand, the WHO has proposed that the handling of food packages or containers contaminated with SARS-CoV-2 could result in the transmission of the virus through contact with the mouth, nose, or eyes [11].

Moreover, foodborne illnesses can affect anyone, but the young, old, pregnant, and immunosuppressed

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groups are at the highest risk [12]. In particular, children are more susceptible to foodborne illness than adults because their immune systems are not fully developed, they weigh less, produce less gastric acid, and cannot cook for themselves [13]. According to statistics, in developing countries, there is a significant number of annual deaths due to foodborne diseases, reaching 2.2 million, mainly in children, with an estimated 1.9 million child deaths [14]. However, it has been noted that the transmission of foodborne diseases tends to increase due to unsafe food-handling practices [14]. A food handler is a person who handles food or anything that is highly likely to come into contact with food or foodstuffs [15]. In households where primary food handlers, often mothers, prepare meals for young children, unsafe food handling practices can increase the risk of foodborne diseases [16]. Mothers are usually a final defense against foodborne diseases [17] because they are the usual food handlers in households [12, 14]. To protect the health and well-being of children, it is essential to assess the beliefs and behavior of mothers and to gather information on the factors contributing to food hazards in the home, to reduce these risks [16]. Among many factors, one of the main factors is a shortage of knowledge and training of mothers in food handling, accounting for 80% of preventable food safety incidents in households [18].

Therefore, there is a strong need to explore and continuously evaluate the food safety practices of mothers [14]. This research aimed to evaluate the knowledge, attitudes, and practices (KAPs) of mothers residing in Jordan during the COVID-19 pandemic and how they handle the world's most fatal crises.

Materials and Methods

Ethical approval and Informed consent

This study was approved by the Ethics Committee, University of Petra, Jordan, with approval number [S/4/9/2023]. Informed written consent was obtained from all participants involved in this study. Participants were provided with detailed information about the research's purpose, procedures, potential risks, and benefits. They were assured of the confidentiality of their responses and were allowed to ask questions before providing their consent.

Study period and location

This study was conducted from 2nd of September 2023 to 2nd of October 2023 in Jordan. The questionnaire was distributed online in Jordan with the intention of gathering responses from a diverse range of Jordanian mothers across various regions, cities, and provinces. This approach was chosen to ensure a comprehensive understanding of the knowledge and practices related to food safety among Jordanian mothers, irrespective of their specific geographical location.

Study participants

We designed a cross-sectional study and distributed a survey among a group of Jordanian mothers who

are investigating their KAPs with regard to food handling amidst the COVID-19 pandemic. After careful examination of the collected data, 376 voluntarily participating mothers were sampled. This cross-sectional study used convenience sampling (non-probability sampling method) to select participants [19]. Due to the lack of a framework for population sampling, if 50% of the population possessed the factor of interest, 369 participants would have to assess the predicted proportion with 5% absolute precision and a 95% confidence interval (CI). In other words, if a random sample of 369 individuals from a population reveals that 50% of them have a factor of interest, there is a 95% probability that the factor of interest affects between 45% and 55% of the population [20].

Questionnaire

Data were gathered using a 55-item self-report questionnaire designed by the researcher, divided into the following four sections:

1. The demographic section includes 10 items related to mothers (age, marital status, educational level, family income, employment status, family economic status, and information sources)
2. Food safety knowledge questions included 12 items. Scores for the knowledge section answers were as follows: correct answer = 1 and false answer = 0
3. Food safety attitude questions included seven items. A positive attitude was given a higher score, and a negative attitude was given a lower score
4. The food safety practices scale contains 26 items. The section on practices involved inquiries regarding behavioral modifications during the COVID-19 pandemic, with response options of "Less than before," "About the same," and "More than before," respectively.

To ensure this research's suitability for the present study, we developed a questionnaire that included specific questions from previously conducted validated and reliable studies on food safety [21–23]. The data for this study were collected using Google Sheets, an Internet-based platform. The main approach used by the researchers was to distribute invitation links primarily within mother groups on well-known social media platforms such as Twitter and Facebook. These links were shared by researchers and volunteers, who distributed them to other potential participants in universities or other academic institutions. Participants were informed of the voluntary nature of their participation, and their consent was obtained before the start of the survey. Informed consent forms containing all the information about the study were provided for transparency. In addition, they were informed of their right to withdraw from the investigation at any time without being subjected to any pressure or consequences. It should be noted that the respondents were not coerced or influenced in any way as the survey was completed anonymously through an online link.

All collected responses were treated as confidential and handled with the utmost confidentiality.

Face and content validity of the questionnaire

The questionnaire was initially drafted in Arabic and then translated into English using the forward-backward translation method [24]. The participants' language preferences were considered during the study. Initially, a researcher proficient in Arabic and English translated the questionnaire from Arabic to English. Subsequently, another bilingual researcher translated the questionnaire from English to Arabic. To ensure the accuracy and correct interpretation of the questionnaire items, the two English versions (the original and the translated version) were compared. The accuracy of the Arabic translation was confirmed by a panel of five nutrition experts who served as reviewers. The questionnaire was revised and corrected as necessary based on the nutrition experts' feedback. The panel concluded that the questionnaire had face and content validity because it was transparent, simple to understand, covered the pertinent aspects of the topic, could be used in future studies, and respected the confidentiality of the participants. The English version of the questionnaire is available as supplementary material.

Psychometric validation of the Arabic questionnaire

For a pilot study, a group of 28 adult participants was selected to test the Arabic version of the questionnaire. To assess the construct validity of the questionnaire, correlation matrices were used to estimate the association between the scale items. The reliability of the questionnaire was evaluated through multiple approaches, including internal consistency measurement using Cronbach's alpha, test-retest reliability measurement using Pearson's *r*, and inter-rater reliability assessment using Cohen's kappa statistic.

Statistical analysis

The Statistical Package for the Social Sciences version (SPSS Inc., Chicago, IL, USA) was used for

all analyses. The sociodemographic characteristics of participants are presented as frequencies "n" (%). Some categories were merged during the analysis due to the low frequencies. Based on the results, KAP categories and overall were categorized as poor ($\leq 80\%$) and good knowledge ($>80\%$), positive ($\leq 80\%$) and negative attitude ($>80\%$), high-risk ($\leq 80\%$) and low-risk practice ($>80\%$), and poor ($\leq 80\%$) and good KAP ($>80\%$). Logistic regression models were used to determine the factors that could determine the overall KAP toward food safety and personal hygiene among mothers during the COVID-19 crisis. The odds ratio (OR) was used to estimate the risk of poor knowledge, negative attitudes, or high-risk practices concerning sociodemographic characteristics (six variables). The dependent variables were the independent variables and the KAP categories. A $p < 0.05$ and a 95% CI were statistically significant.

Psychometric validation of the Arabic questionnaire

Correlation coefficients (*r*) observed in the study ranged from 0.56 to 0.74, with a mean value of 0.65. These findings indicate acceptable construct validity. The questionnaire showed high internal consistency with Cronbach's alpha value of 0.95, indicating excellent internal consistency. The test-retest reliability, as measured by Pearson's *r*, yielded a coefficient of 0.677, indicating good stability over time. In addition, Cohen's kappa statistic resulted in a coefficient of 0.93, indicating a high level of agreement among the raters. These results suggest that the questionnaire is reliable, with consistent and stable measurements, and there is a minimal possibility of measurement error due to tool changes.

Sociodemographic characteristics of the participants

A total of 376 mothers participated in the survey. The sociodemographic characteristics of the participants are presented in Table-1, which summarizes relevant information.

Results

Overall, more than two-thirds (79.8%) of the mothers had poor KAPs, Figure-1 and Table-2.

Table-1: Sociodemographic characteristics.

Demographic factors	Categories	Frequency (n)	Percentage
Age (year)	≤ 30	147	39.1
	> 30	229	60.9
Status	Married	336	89.4
	Divorced or widowed	40	10.6
Education level of the mother	\leq Secondary school	96	25.5
	$>$ Secondary school*	280	74.5
Family income/month (Jordanian Dinar)	< 500	119	31.6
	500–700	190	50.5
	> 700	67	17.8
Job	Home wife	296	71.5
	Full time	61	16.2
	Part-time	46	12.2
Information sources	Social media	28	7.4
	Training or workshop	148	39.4
	Health professional	41	10.9
	Social surrounding	159	42.3

Social surroundings include family and friends. *Include Diploma, bachelor's degree, and high education level

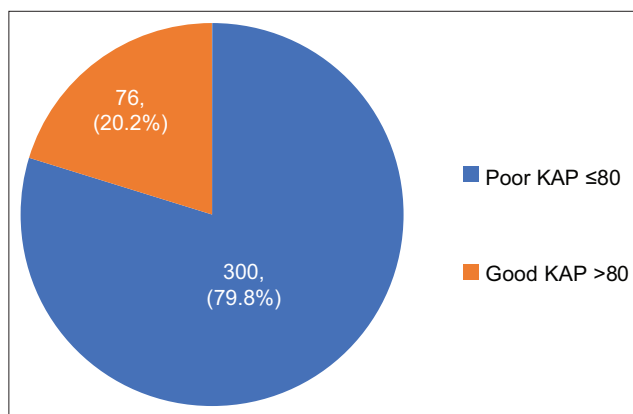


Figure-1: Knowledge, attitudes, and practices categories regarding food safety and hygiene.

Mothers' KAP response

Knowledge

The study results demonstrate that a considerable majority of the participants (94.1%) were aware of the ability of individuals infected with the COVID-19 virus to spread the virus through coughing or sneezing, even if they did not show symptoms. Similarly, 92.6% of respondents were aware that hand hygiene could minimize the transmission of germs related to food after handling raw food. Furthermore, when queried about the presence of the virus in the nose and mouth of infected individuals, 83% provided an accurate response. Encouragingly, an average of 72% of the respondents were knowledgeable about the appropriate method of drying hands after washing, which involves using tissue paper. In addition, they recognized that using a separate cutting board for vegetables, rather than one previously used for cutting raw meat, is the appropriate procedure. Among the mothers surveyed, 70% knew that their hands should be washed after touching their faces when preparing food. Approximately 38% of the respondents correctly identified that a temperature of 70°C is appropriate for killing the COVID-19 virus during cooking, and 20 s is recommended for washing hands. In addition, they acknowledged that kitchen surfaces should be cleaned with a detergent, rinsed with a sanitizing solution, and wiped with a sanitizer. However, only 25.3% and 24.2% of the participants were aware that the COVID-19 virus could be found in drinking water and that using a food thermometer to ensure sufficient poultry cooking is the best approach. The lowest percentage (18.1%) identified washing vegetables with cold running water as the correct method (Table-3).

Attitudes

The findings indicated that most participants, specifically 92.6%, believed that when a family member or friend is infected with COVID-19, it is necessary to reduce the number of people involved in food preparation. In addition, approximately 79.6% of the participants believed that even if they received the

Table-2: KAP mean and category frequencies regarding food safety and hygiene.

KAP	Categories	n (%)	Mean±standard deviation
Knowledge	Poor≤80	365 (97.1)	54.65±14.38
	Good>80	11 (2.9)	
Attitude	Negative≤80	206 (54.8)	76.21±10.11
	Positive>80	170 (45.2)	
Practice	High risk≤80	196 (52.1)	78.28±8.81
	Low risk>80	180 (47.9)	

KAP=Knowledge, attitudes, and practices

Table-3: Knowledge response toward food safety and hygiene.

Knowledge questions	Correct answer n (%)
K1	312 (83)
K2	354 (94.1)
K3	95 (25.3)
K4	141 (37.5)
K5	91 (24.2)
K6	348 (92.6)
K7	139 (37)
K8	264 (70.2)
K9	229 (60.9)
K10	68 (18.1)
K11	277 (73.7)
K12	148 (39.4)

COVID-19 vaccine, it may not fully protect them from infection while eating at food-serving establishments such as restaurants and cafes unless they adhere to the recommended safety measures to minimize the risk of transmission. However, 78.5% of the participants did not endorse using hand sanitizers as a substitute for washing hands with soap and water to effectively eliminate germs. The majority of participants believed that COVID-19 could be transmitted through food, but they did not believe that the virus could grow in food. Regrettably, only approximately 27.7% of the participants recognized that cooling, refrigerating, or freezing food is an effective method to inhibit or kill the COVID-19 virus. A similar percentage (21%) of the participants were aware that common household items such as lemon juice, pepper, salt, or vinegar could not remove germs such as COVID-19 from food preparation surfaces (Table-4).

Practices

The results of the research showed that there were significant changes in mothers' practices after COVID-19 infection. 94.9% of the mothers who participated in this study still prepared food by themselves. Approximately 83.2% of the participants reported eating less food in restaurants than before COVID-19. Observations revealed a significant decrease in certain practices among mothers during the COVID-19 period compared to the previous periods. For example, 66.5% of the participants reported eating meals with family or at friends' homes. Similarly, 83.2% of mothers went to restaurants to eat, indicating a reduction in this practice. In addition, 64.9% of mothers

reported an increased reliance on the purchase of food delivered to the home.

Concerning hand washing practices, it was found that 95.7%, 97.7%, 96%, and 97.9% of the participants were committed to washing their hands when touching bags and outer covers, returning home while preparing food, or before eating, respectively. Looking at the practices related to purchasing food, it was mentioned that 47% of mothers still go by themselves to buy food from large shopping centers in a similar way to what they did before COVID-19; however, 66.2% of them mentioned that this took less time and 59.6% mentioned that the number of visits has become less than before the pandemic. The results of the research showed that although the percentage of mothers visiting restaurants during that period was lower, they reported that they began to practice some preventive measures such as checking the sterilization of tables and chairs before sitting (83.2%), as well as making sure of sterilization procedures in the bathroom before using it (92.3%), sterilization procedures, and general safety for workers such as wearing masks, gloves (89.4%), and social distancing between visitors (82.2%). Among the remarkable practices applied by a high percentage of mothers, 71% reported disposing of all shopping bags after emptying their contents, 81.1% disinfected food packages before using them, and 74.5% used a separate sponge, especially

for washing dishes, which differs from that used for cleaning the sink.

The determinant factors of KAP

The binary logistic regression model (B) explained 19.0% (Nagelkerke R^2) of the variance of KAP. The model was statistically significant ($\chi^2_{25} = 114.32$, with $p < 0.0001$) Hosmer and Lemeshow's goodness-of-fit test was $\chi^2_{27} = 5.24$ and $p = 0.732$, demonstrating good fitting. The mother's age, education level, monthly income, and information source were significantly associated with the mothers' KAP. The OR for KAP, based on the mothers' characteristics, is summarized below (Table-5).

Discussion

Knowledge

Some viral infections in close proximity can be highly contagious [25]. COVID-19 is highly contagious, and its transmission can occur through respiratory aerosols. These infecting aerosols may be transmitted to a walking person during regular respiration. In addition, COVID-19 infection can be transmitted through droplets generated during sneezing or coughing [26]. Interestingly, it has been reported that individuals infected with COVID-19 can transmit the infection to other people during the incubation period. In addition, the COVID-19 virus may be transmitted from infected individuals to other people even if the infected individual is symptomatic or asymptomatic [27].

Al-Hanawi *et al.* [28] studied the KAPs toward COVID-19 transmission among Saudi Arabians. According to the results of this study, approximately half of the respondents were unaware that SARS-CoV-2 could be transmitted from person to person in close proximity. In addition, approximately 94.8% of the participants knew that COVID-19 infection may spread through contaminated droplets generated during coughing or sneezing. Unfortunately, only 14.9% of the participants in that study knew that

Table-4: Attitude response toward food safety and hygiene.

Attitude questions	Agree n (%)	Neutral n (%)	Disagree n (%)
A1	216 (57.4)*	63 (16.8)	97 (25.8)
A2	70 (18.6)	93 (24.7)	213 (56.6)*
A3	141 (37.5)	131 (34.8)	104 (27.7)*
A4	348 (92.6)*	16 (4.3)	12 (3.2)
A5	233 (62.0)	64 (17.0)	79 (21.0)*
A6	73 (19.4)	15 (4.0)	288 (79.6)*
A7	58 (15.4)	23 (6.1)	295 (78.5)*

*Correct response

Table-5: Binary logistic regression of KAP and sociodemographic characteristics.

Characteristics	Categories	" β coefficient"	Odds ratio (confidence interval 95%)
Age (year)	≤ 30	0.63	1.88 (1.05, 3.38)*
	> 30	-	-
Status	Married	0.30	1.35 (0.51, 3.55)
	Divorced or widowed	-	-
Education level of the mother	\leq Secondary school	1.13	0.31 (1.60, 5.97)*
	$>$ Secondary school	-	-
Family income (JD) monthly	< 300	-1.06	0.35 (0.15, 0.80)*
	300-700	-0.24	0.79 (0.39, 1.57)
	> 700	-	-
Job	Home wife	0.59	1.80 (0.63, 5.11)
	Full time	0.86	2.36 (0.72, 7.69)
	Part-time	-	-
Information sources	Social media	1.45	4.28 (1.51, 12.13)*
	Training or workshop	1.53	4.61 (2.33, 9.15)*
	Health professional	1.52	4.57 (1.84, 11.41)*
	Social surrounding	-	-

Positive KAP (> 80) is the reference category; *statistically significant at $p < 0.05$. KAP=Knowledge, attitudes, and practices

people with no fever could transmit the COVID-19 virus to other people around them.

Our results indicated that approximately 94.1% of our respondents knew that individuals infected with the COVID-19 virus, regardless of whether they were symptomatic or asymptomatic, may transmit the infection to other people through contaminated droplets generated during sneezing or coughing. The higher percentage of participants in the present study compared with those in the Al-Hanawi study regarding the transmission of COVID-19 infection from asymptomatic individuals may stem from the differences in general knowledge and awareness between the Jordanian and Saudi Arabian populations.

Coronaviruses are heat-labile; therefore, the normal cooking temperature of meat and eggs effectively inactivates these viruses [27]. In a study by Soon *et al.* [29], approximately 58% of the participants were unaware that cooking temperatures above 70°C can destroy the COVID-19 virus. According to our data, approximately 38% of the respondents knew that cooking temperatures above 70°C can completely inactivate the COVID-19 virus. Our results were comparable to the results of two studies conducted by Osaili *et al.* [23] and Soon *et al.* [29], in which approximately 33% and 41% of their respondents were aware that cooking temperatures above 70°C can effectively inactivate and kill COVID-19 virus. Hand hygiene is a standard way to limit the transfer of microbial pathogens by healthcare workers [30], field workers [31], and food workers [32]. To obtain a good level of hand hygiene, not only hand washing but also the duration of the washing process as well as the method used for hand drying after the washing process [32–34].

Tissue paper is the best and the most efficient method for hand drying. Other methods used to dry hands, such as warm-air dryers (including jet dryers), may produce aerosols contaminated with microorganisms [35]. However, other studies have reported no differences in hand hygiene between the use of tissue paper and other methods [36].

Our study indicated that approximately 92.6% of the respondents agreed that cleaning their hands after handling uncooked food aids prevents the spread of foodborne diseases. Sharif and Al-Malki [37] conducted a study among university students in Saudi Arabia and found that washing hands before handling or preparing foods reduced microbial transmission. In a study by Hassan and Dimassi [38], approximately 87% of the participants agreed that washing their hands with soap and water before eating or preparing food reduces the transmission of microbes; however, in that study, only about 37% of the participants were aware that 20 s is the best time required for efficient hand washing. Similar results have been reported by Osaili *et al.* [23]. During that study, approximately 36.2% of the participants knew how long it took to wash their hands. In contrast to this study, Reuben

et al. [39] conducted a study in North Central Nigeria where 82.3% agreed that hand washing should last from a minimum of 20 s to 1 min. In a previous study, 75.2% of respondents did not follow proper hand-washing techniques [16, 40].

In our study, approximately 70.8% of the participants were aware that tissue paper was the most effective method for drying their hands after washing. A separate study conducted in the United States during the COVID-19 pandemic focused on hand drying in public restrooms and found that 55.4% of respondents preferred paper towels for hand drying. Considering the possibility of surface contamination, this preference was driven by the belief that paper towels could be utilized to touch surfaces and minimize the risk of contracting the COVID-19 virus [41]. In another study conducted by Al-Wutayd *et al.* [42], approximately 63% of the participants agreed that tissue paper is the best method for drying hands.

Fruits and vegetables play a crucial role in a healthy diet [43]. A number of studies have shown that rinsing fresh fruits and vegetables with cold running water effectively reduces the presence of bacteria that could potentially harm them. However, it should be noted that no washing method can remove or eliminate all microbes present in these food items [44]. Proper washing of fresh fruits and vegetables is a good practice to minimize the ingestion of potentially harmful microorganisms that may contaminate them. Numerous people handle fresh fruits and vegetables before they reach grocery store customers. Therefore, it is always better to assume that not all hands handling these fresh fruits and vegetables are clean [45]. In our survey, most of the respondents had poor knowledge about how to wash fresh fruits and vegetables, and only about 18% of the respondents knew the correct washing method. Osaili *et al.* [22] investigated female college students' food safety knowledge and practices regarding washing fresh fruits and vegetables in the northern part of Jordan. Only approximately 28.4% of respondents knew the correct answer in that study. On the other hand, a Canadian study showed that approximately 92.5% of participants knew that fresh fruits and vegetables must be washed with cold water [46]. A study conducted in Saudi Arabia by Ayaz *et al.* [12] to examine mothers' food safety knowledge and practices revealed that 54.6% of respondents knew that fruits and vegetables should be rinsed under cold running water.

COVID-19-infected surfaces may function as vectors for virus transmission. This infection may be present on surfaces such as cutting boards. Approximately 73.7% of the respondents knew that meat and vegetables should be cut separately. Our results were almost similar to those of a study that investigated the knowledge of Saudi mothers regarding the usage and maintenance of their kitchen facilities [12]. In that study, approximately 78.5% of the

respondents knew the correct answer about using separate chopping boards. Almost 39.4% of our respondents knew how to clean kitchen surfaces: washing, rinsing, and wiping with a sanitizing solution. Our results regarding awareness of the correct way to clean kitchen surfaces were comparable to those obtained by Ayaz *et al.* [12], in which approximately 42.3% of the respondents knew the correct way.

Attitudes

Viruses cannot reproduce freely in food or water as obligate intracellular microorganisms. To replicate, viruses need a living host cell so that they, including the COVID-19 virus, can use their molecular machinery to make copies of themselves [22].

According to the WHO, COVID-19 is transmitted primarily by direct contact with respiratory particles produced when an infected person speaks, coughs, or sneezes. Alternatively, if the respiratory droplets are too heavy to be transported by air, they will be deposited on the surrounding objects and surfaces. When contacting these contaminated objects and surfaces with other people, their contaminated hands may transmit the infection to them by touching their mouths, noses, or eyes with their contaminated hands. A study conducted by Soon *et al.* [29] has reported that slightly more than half (50.3%) of the participants were uncertain or unaware that COVID-19-infected food handlers who are asymptomatic may transmit the infection to other people who handle food or food packages through their contaminated hands. However, the respondents indicated that they would carefully remove the food packaging and wipe the food jars or cans before eating them. Our results indicated that approximately 57.4% of the participants agreed that the COVID-19 virus could possibly be transmitted through food. According to the European Commission, 2020 US Food and Drug Administration, 2020 WHO 2020, there is no evidence that food or food packaging is linked to COVID-19 transmission. However, recent studies have reported the possibility of COVID-19 transmission through refrigerated and frozen food products. In Auckland, New Zealand, a worker was infected with COVID-19 while handling frozen foods. In addition, two dockers handling imported frozen seafood were infected with COVID-19, leading to a small-scale outbreak [47]. In Beijing, China, no new cases of COVID-19 infection were reported after 56 days. The China Centers for Disease Control and Prevention (CDC) has identified a new COVID-19 infection cluster, with the source of the virus being imported frozen salmon [48]. In January 2022, a study found that COVID-19 can remain infectious on refrigerated deli food and meat for up to 21 days [49]. In addition, a review article suggested that contaminated cold-storage foods may pose a risk of SARS-CoV-2 transmission at national and international levels [48].

In this study, 79.6% of the participants believed that the COVID-19 vaccine would not protect them

from infection at food-serving places if they did not comply with the recommended general safety measures. Our results are consistent with those of a study conducted by Osaili *et al.* [22], which reported that many study participants believed that vaccination alone would not protect against COVID-19. That study indicated that it is important to comply with the recommended general safety measures to avoid COVID-19 infection. Interestingly, the CDC and WHO have also recommended the following standard safety measures in public settings, even if fully vaccinated [50, 51].

It has been shown that natural acidic substances, high salt concentrations, and pepper have antimicrobial activities [52]. For example, vinegar is well-known for its antimicrobial activity against bacterial pathogens that may be present in fresh fruits and vegetables [53]; however, it is not effective against coronavirus [54]. Conversely, consuming acidic beverages, such as lemon juice, does not affect COVID-19 infection. This is because viral infection occurs in the body when viruses enter the body, replicate themselves, and then spread to new cells. Therefore, lemon juice has no ability to remove viruses or prevent their replication [55]. Our data indicated that only about 21% of respondents believe that lemon juice, pepper, salt, and vinegar are effective cleansing agents. Osaili *et al.* [22] discovered that most respondents had erroneous beliefs regarding the cleansing capabilities of lemon juice, pepper, salt, and vinegar. A low percentage of our respondents were aware of the effectiveness of lemon juice, pepper, salt, and vinegar as cleaning items most likely stemming from the fact that the majority of respondents (296 out of 376) are homemakers and that about 42.3% of them get their information from their social environment (Table-2).

Hand washing is essential to avoid infection with many pathogens [56]. It has also been found that hand washing is better than wearing disposable gloves in terms of avoiding microbial infection [57]. Kaltenthaler and Drasar [58] found that washing hands with soap and water is more effective than hand sanitizers in removing certain microbes, pesticides, and other chemical residues from hands. In addition, the WHO recommends that hand sanitizers can be used as an additional measure, but should not replace hand washing. Most of the participants (78.5%) in our study did not believe that using hand sanitizers to kill germs on hands can replace washing hands. These results are consistent with those of a study conducted in Saudi Arabia to evaluate the knowledge and hand-washing habits of the Saudi population during the COVID-19 outbreak. The study indicated that a notable portion of the participants favored using soap and water for hand washing as a preventive measure against COVID-19 instead of alcohol-based disinfectants [59]. In addition, our results agree with the results of another study conducted by Almoslem *et al.* [60], which investigated the level of KAPs of hand

washing with soap and water among students in Eastern Province Schools of Saudi Arabia. In that study, it was found that approximately 97% of students believed that hand washing with soap and water was the best method to clean their hands. Our study showed that maternal education correlates significantly with good hand hygiene practices among Jordanian mothers.

Practices

The study revealed that, after the COVID-19 era, mothers' practices significantly changed. A large proportion of mothers still prepared their food by themselves. Our results are consistent with what Kantar [61] reported. According to Kantar's Consumer Insights Report, social isolation for more than 2 months has changed the consumption habits of Brazilians, with a 27% increase in the consumption of food and beverages at home. The frequency of breakfast increased by 25%, lunch and dinner by 30%, and snacking by 21%. In addition, there was a reduced frequency of dining at restaurants compared to the period before COVID-19 onset. According to a similar survey conducted in Brazil by Rodas [62], 95% of the Brazilian participants chose to stay at home due to the fear of contracting the virus, and 93% reported an increase in cooking at home. A significant number of respondents believed that food could be a potential source of virus contamination [63]. During the COVID-19 period, it was shown that some of the practices of mothers were less similar to what they used to be. For example, they used to go to a friend's house or eat at home, and about 66.5% of them did it. They also like to eat at restaurants (83.2%). In addition, their reliance on buying food at home increased.

Botelho *et al.* [64] reported that physical distance contributes to food delivery. Rodrigues *et al.* [63] also found that more Brazilians prefer eating at home because it is safer. The possibility of working from home and having more time to prepare and cook nutritious meals, thereby reducing the consumption of food outside the home, may also contribute to an increase in the consumption of home-cooked foods [65]. It has also been reported that almost half of the mothers continue to go to supermarkets and shops to buy food, similar to before the COVID-19 pandemic. However, 66.2% reported that this method has become faster, and 59.6% reported that the number of visits to these establishments has decreased. Typically, women are entrusted with the responsibility of grocery shopping and overseeing the management of household food [66, 67]. This confirms that nearly 50% of mothers purchase food products from retail stores [67]. Moreover, the lower frequency of going to shopping centers was consistent with numerous studies by Galindo *et al.* [68] and Njora and Yilmaz [69].

Some of the practices reported by mothers were as follows: they usually put away all their shopping bags after emptying and disinfecting food packages before using them. In addition, they use a sponge for

washing dishes, which is significantly different from the sponge used for washing dishes. The packages were immediately discarded out of concern that the coronavirus could infect their surfaces [63]. People's fear of contracting COVID-19 was demonstrated by adhering to preventive measures such as personal hygiene, hand sanitization, and social distancing [70, 71]. Our results showed that the participants were committed to hand washing after touching bags and outer covers when returning home while preparing food or before eating. People, especially mothers, were trying to avoid visiting restaurants or practicing preventive measures to avoid infection.

Conclusion

During the COVID-19 epidemic, Jordanian mothers had a low level of awareness of food safety, negative attitudes, and unsanitary practices. However, the COVID-19 epidemic has led to dramatic changes in the attitudes of Jordanian mothers toward food handling in many aspects of daily life. After the pandemic, many moms adopted more careful food preparation and handling methods due to their increased knowledge of cleanliness and safety procedures. As a result of an increased emphasis on sanitation and hygiene, mothers were likely to be more diligent in cleaning and disinfecting food items, implementing appropriate storage practices, and following recommended food safety rules. In addition, the trend toward home cooking and avoiding outside food sources may have pushed mothers to prioritize nutrition and good eating habits for their families. It can be said that this experience has increased mothers' awareness and has provided the groundwork for advocating and implementing more stringent food safety standards in the future.

Data Availability

The data and materials supporting the findings of this study as well as the questionnaire are available upon reasonable request.

Authors' Contributions

ODAM: Conceptualization, design of the study, project administration, and edited the manuscript. ODAM, MMA, and MSQ: Collection of data. NAE and ODAM: Formal analysis and interpretation of data. ODAM, MMA, NAE, and MSQ: Writing original draft preparation. All authors have read, reviewed, and approved the final manuscript.

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Competing Interests

The authors declare that they have no competing interests.

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