

Evaluating food safety knowledge and practices among Saudi women in Al-Ahsa Region, Saudi Arabia

Fahad Al-Asmari,¹ Ahmed I.H. Ismail^{2,3}

¹Department of Food Science and Nutrition, College of Agriculture and Food Sciences, King Faisal University, Al-Hofuf, Saudi Arabia; ²Department of Agribusiness and Consumer Sciences, College of Agriculture and Food Sciences, King Faisal University, Al-Hofuf, Saudi Arabia; ³Rural Community and Agric. Extension Department, College of Agriculture, Ain Shams University, Egypt

Abstract

Foodborne illnesses are responsible for about half a million deaths annually, of which 30% occur among kids. This study aimed to assess the current food safety knowledge and practice level of Saudi women in Al-Ahsa region, Saudi Arabia. A cross-sectional study was conducted through personal interviews among 239 Saudi women. The questionnaire consisted of close-ended questions covering different aspects of food safety knowledge and practices at home and during shopping. Descriptive analyses were used to identify the level of participant's awareness, and the scores were shown in three categories (good – fair – poor) based on their food safety knowledge and practice awareness. The effect of socio-demographic characteristics and their correlation to food safety knowledge and practices was conducted using Chi-square analysis. The results about food safety knowledge showed that around 50% of participants achieved a good score, and 37.5% achieved a fair score, while 12.5% achieved a poor score. In comparison, the participants achieved 75% good score, whereas 12.5% achieved both fair and poor in food safety practices. The results also highlighted a significant correlation ($P < 0.05$) between level of food safety knowledge, practices of participants and their age, marital status, work status, and educational level, while there's no correlation with their family size and total income. Although, the overall result showed good level in food safety knowledge and slightly less in food safety practices among Saudi women living in Al-Ahsa region, continuous education, training, awareness, and motivation are highly recommended to improve women's knowledge and practices to higher levels.

Introduction

Food safety is a major concern for consumers, food service suppliers, and governmental authorities. Foodborne illnesses, also known as food poisoning, are a global health issue that affects people in developed and underdeveloped countries. It has been recognized by the World Health Organization (WHO) as a globally foremost public health threat in the 21st century. The WHO states that foodborne illnesses are responsible for over 600 million cases and 420,000 deaths annually (WHO, 2017). About 30% of deaths occur among kids due to their immature immune system and lower body weight. The Centers for Disease Control and Prevention (CDC) indicated that foodborne illnesses strike an estimated 48 million Americans, of which 3000 die annually. The prevalence of food-related illnesses has also become one of the most significant factors affecting the global economy. The global productivity loss caused by foodborne illnesses is estimated to be around US\$ 95.2 billion annually (Bank, 2018). In the United States the estimated cost of food safety outbreaks on food businesses or companies is about US\$15.5 billion every year (Hoffman *et al.* 2015). Salmonellosis caused by *Salmonella* species was found to be responsible for 31% of all reported outbreaks, 18.8% due to bacterial toxins, 10.1%, and 27.1% caused by unknown agents (Jevšnik *et al.*, 2013). The previous figures may not reflect the mass of global unreported household outbreaks that occur daily (Farahat *et al.*, 2015). Improper handling of food at home can lead to various foodborne illnesses such as diarrhea, fever, sore throat or flu (Usfar *et al.*, 2010). In 2010, the CDC reported that about 21% of the foodborne illness cases they investigated were caused by food consumed in a private home (Parra *et al.*, 2014). In Europe, most of the foodborne outbreaks are caused by improper handling of food at home, followed by restaurants, cafes, hotels, and schools (EFSA, 2011). Housewives play a vital role in reducing the toll of foodborne illness (Fischer *et al.*, 2007). Several reports measuring consumers' food safety knowledge, attitudes, and personal hygiene practices showed the role of households in reducing foodborne illness outbreaks (Angelillo *et al.*, 2001; Ayaz *et al.*, 2018; Hillers *et al.*, 2003; Kagan *et al.*, 2002; Redmond & Griffith, 2003; Unusan, 2007). Previous studies have shown that the increasing number of foodborne illnesses is linked to the lack of hygienic food handling practices at home (Ahmed, 2015; Hassan *et al.*, 2018; Young & Waddell, 2016). Also, it has been indicat-

Correspondence: Fahad Al-Asmari, Department of Food Science and Nutrition, College of Agriculture and Food Sciences, King Faisal University, P.O. Box 400, Al-Ahsa 31982, Al-Hofuf, Saudi Arabia. Tel.: +966135895747. E-mail: falasmari@kfu.edu.sa

Key words: Food safety; Foodborne illnesses; Food knowledge; Food practices; Saudi women; Al-Ahsa region.

Acknowledgements: The authors would like to thank King Faisal University for supporting this research.

Contributions: FA, AI, conceptualization; AI, methodology; FA, AI, formal analysis; FA, AI, investigation; AI, writing - original draft preparation; FA, writing - review and editing. All authors have read and agreed to the published version of the manuscript.

Conflict of interest: The authors declare no potential conflict of interest.

Funding: This research was funded by the Deanship of Scientific Research (DSR) at King Faisal University under (Ambitious Researcher) track with project No. GRANT258.

Received for publication: 4 July 2022.

Revision received: 14 January 2023.

Accepted for publication: 16 January 2023.

This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License (CC BY-NC 4.0).

©Copyright: the Author(s), 2023

Licensee PAGEPress, Italy

Italian Journal of Food Safety 2023; 12:10716

doi:10.4081/ijfs.2023.10716

Publisher's note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article or claim that may be made by its manufacturer is not guaranteed or endorsed by the publisher.

ed that about 50 to 87% of reported food poisoning incidents happened at home due to lack of education and food safety awareness (Ayaz *et al.*, 2018). Therefore, education and hands-on training for housewives, who are mainly responsible for preparing food at home, is crucial.

In 2018, the ministry of health in Saudi Arabia, reported that 176 foodborne illness cases occurred at home, mostly between children. The report pointed out the increase in foodborne incidents at home by 65%

between 2014 and 2018. The main cause of foodborne illnesses was Salmonellosis (61.11%) followed by *Escherichia coli* (28.5%), *Staphylococcus aureus* (6.1%) and lastly Shigellosis (5.1%) (MOH, 2018).

Similar studies were carried out all over the cities in Saudi Arabia to assess food safety knowledge, practices, and behaviors of women (Arfaoui *et al.*, 2021; Ayad *et al.*, 2022; Ayaz *et al.*, 2018; Farahat *et al.*, 2015). However, there was no study conducted on Saudi women living in Al-Ahsa region. This research evaluates the current food safety knowledge and practices among Saudi women living in Al-Ahsa region, and the factors affecting food safety handling.

Materials and Methods

Questionnaire design

Close-ended questionnaire with multiple-choice questions was performed on 239 Saudi women living in Al-Ahsa region (Eastern province, Saudi Arabia). The questionnaire survey was adopted by validated questionnaire used in previous studies with modification (Arfaoui *et al.*, 2021; Farahat *et al.*, 2015; Naeem *et al.*, 2018; Unusan, 2007). Each questionnaire took about 25 minutes to complete. The original questionnaire version was written in Arabic, then it was carefully translated into English. All participants were informed that no names or any other identifier would be collected or used in the reports. The questionnaire consisted of three distinctive domains: socio-demographic, food safety knowledge, and food safety practices. All questions were designed to assess the level of food safety knowledge and practices and to identify the factors affecting food safety handling behaviors of participants. The themes of questions were personal hygiene, storage temperature, reheating leftover food, shopping behavior, cross-contamination, thawing raw meat. Irrelevant and unclear questions were not included. The results were categorized into three levels (good – fair – poor) based on the value of each question.

Data collection

This survey was carried out on Saudi women living in Al-Ahsa region. Approximately 300 Saudi women were questioned, only 239 women (about 80%) fully responded to all given questions, while the rest was excluded. The survey was conducted between 2021 and early 2022 through personal interviews by three master's students from King Faisal University. The interviews were conducted at different shopping malls.

Data analysis

The socio-demographic characteristics (independent variable) of participants, including age, marital status, educational level, work status, family size and total income, were collected. A variable data was created on SPSS (version 28) and descriptive statistic was used to calculate the mean and the percentages of the responses. Non-parametric analysis (Chi-square) was used to identify the correlation between food safety knowledge, practice level and the socio-demographic characteristics. The significance level (α) was set at P-value <0.05 for descriptive analyses. Sixteen questions distributed on seven domains including personal hygiene, food storage, thawing raw meat, preserving leftover food, food reheating, shopping behavior, cross-contamination were analyzed. Each question was given a value; *always* 3 points, *sometimes* 2 points, and *never* 1 point, based on answer accuracy. For each section, mean score and standard deviation were analyzed, and the overall results were presented in this way: i) the score good was given for the questions with a mean ranging between ≥ 2.3 –3; ii) the score fair was given for the questions with a mean ranging between ≥ 1.6 –<2.3; iii) the score poor was given for the questions with a mean ranging between ≥ 1.0 –<1.6.

Results and discussion

Participants profile

The socio-demographic profile of the 239 female participants is illustrated in Table 1. None of them were professional food handlers or had attended food safety training. The results revealed that the mean age of participants was 47.8 years old. The majority of participants (82%) were married, and 13% were single. Most participants (55%) were unemployed and 47.2% had a bachelor's degree. The biggest family size (55.2%) was six members and above. The income ranged from 4,999 to 9,999 Saudi Arabian Riyals (SAR) (equivalent to 1,333–2,666 US\$) in the majority of participants.

Food safety knowledge among participants

Results of overall food safety knowledge level are illustrated in Table 2. Eight questions covering personal hygiene, food storage, preserving leftover food, and reheating food were analyzed. In personal hygiene questions, 82.4% of participants answered question 1 saying that they always wash their hands before preparing food, while the rest do not frequently wash their hands before preparing food. In ques-

Table 1. The socio-demographic characteristics of Saudi women.

Socio-demographic characteristics	Category	No. participants	%
Age group	19–29	66	27.6
	30–39	51	21.3
	40–49	89	37.2
	50–59	26	10.9
	60–69	7	2.9
	Total	239	100
Marital Status	Single	31	13
	Married	196	82
	Separated	7	2.9
	Widowed	5	2.1
	Total	239	100
Work status	Employee	106	44.4
	Unemployed	131	54.8
	Retired	2	0.8
	Total	239	100
Educational level	Primary	27	11.3
	Secondary	91	38.1
	Bachelor	113	47.2
	Postgraduate	8	3.4
	Total	239	100
Family size	≤6 people	107	44.8
	>6 people	132	55.2
	Total	239	100
Total income (SAR)	≤4999 SAR	27	11.3
	5000–9999 SAR	131	54.3
	10,000–19,999 SAR	66	27.6
	>20,000 SAR	15	6.3
	Total	239	100

tion 2, about 76% of women always use soap for washing their hands before preparing food and about 14% only use water. In question 3, as the contact time between hands and soap is crucial, 55.6% of them replied that they wash their hands for less than or equal to 10 seconds, while 36.8% for 11 to 20 seconds. In fact, washing hands thoroughly before preparing food or eating for at least 15 seconds can kill approximately 99% of all living germs in our hands (Curtis, 2008). The lack of personal hygiene that may occur during food preparation can lead to the transfer of food-based ailments. A potential number of foodborne illnesses such as diarrhea could be averted by proper handwashing (Curtis & Cairncross, 2003). The overall result for the knowledge of personal hygiene level was good for questions 1 and 2 with means of 2.82 ± 5.32 and 2.65 ± 4.84 , respectively, and fair for question 3 with a mean of 1.81 ± 2.37 .

Questions 4 and 5 were about food storage behavior. In question 4, about 57% stated they always preserve meat, including beef, lamb, chicken, and fish, under freezing condition, whereas 37.2% prefer the refrigerator. Both answers are correct (with different point values); however, keeping meat under freezer temperature (-18°C) would extend the shelf-life of meat by suppressing microbial growth and maintain the freshness of meat comparing to storing under refrigerator temperature (Hui, 2012). Similarly, in question 5, the majority (65.3%) of participants prefer keeping raw meat inside the refrigerator for more than 7 days, while 25.9% do not keep the meat under refrigerating conditions beyond 7 days. Although, keeping raw meat in the refrigerator could preserve it for a short period of time, spoilage microorganism and some pathogens will grow slowly under

refrigerating condition, resulting in serious health risk. A study conducted on beef samples under different storage conditions revealed that the samples stored in the refrigerator for 14 days presented objective signs of spoilage and were sensorially unacceptable. In addition, the microbial load of psychotropic and mesophilic bacteria was increased from 1 log CFU/g to 5.96 and 5.30 log CFU/g respectively after 7 days of storage under refrigerating condition (Ercolini *et al.* 2006). The responses of question 4 and 5 achieved good and fair scores, respectively, with a mean of 2.52 ± 4.20 and 2.17 ± 2.87 , respectively.

Question 5 was about thawing frozen meat. More than half (53.5%) of participants leave frozen meat at room temperature until thoroughly thawed. About 35% put the meat in warm or hot water before cooking it. Only 12.1% of participants use either refrigerator or microwave to thaw frozen meat. Therefore, the score of this response was poor with a mean of 1.59 ± 1.43 . Despite the potential risks associated with room temperature thawing, almost 50% of consumers still prefer to use this method due to its simplicity. Such behavior allows bacteria and spores to multiply and reach unacceptable level resulting in serious health risk (Akhtar *et al.*, 2013).

Question 7 was about preserving extra or leftover food. Nearly 73% of participants keep the leftover food under refrigerating or freezing conditions, while only 9.6% keep the remaining food at room temperature until the next meal. Indeed, keeping cooked food in a cold place (out of the dangerous zone. $5-60^{\circ}\text{C}$) not only maintain food quality but also prevents or reduces foodborne illnesses. The USDA Food and Poultry Hot Line recommendation is that leftovers or other foods should not be left out for more

than 2 hours at room temperature (Parra *et al.*, 2014). The overall response in this question scored good with a mean (2.64 ± 4.76) as the majority of participants follow the ideal practice. A study carried out on two groups of Mexican Americans living in the U.S. assessing their food safety knowledge and practices, revealed that most participants (74.6%) wash their hands with soap every time before handling food. The study also showed that 48.7% of participants thaw the frozen meat at room temperature for 2 hours or less, and 64.3% place leftover food at room temperature for 2 hours or less (Parra *et al.*, 2014).

Question 8 was about reheating food. More than three-quarters (66.1%) reheat food until it becomes warm (not hot). In turn, 28.9% reheat food until it becomes steaming hot throughout. Failure to reach the correct temperatures could result in food poisoning. This may be attributed to the fact that all food contains microbes, and once these organisms find the optimum temperature, they will rapidly grow and producing toxins. Many microorganisms are able to secrete toxins during improper storing, such as *Clostridium botulinum*, *Bacillus cereus*, and *Staphylococcus aureus*. Therefore, high temperatures (steaming hot) used to reheat food could destroy or reduce the microbial load. Also, although some bacterial toxins are heat-stable, exposing leftover food to high temperature during reheating could destroy or reduce the risk of these toxins (Osaili *et al.*, 2011). Thus, the question's response scored fair with a mean of 2.24 ± 3.07 .

Food safety practices among participants

The participants' responses are illustrated in Table 3. There are eight questions cov-

Table 2. The scores of Saudi women's responses to food safety knowledge questions.

No.	Questions	Response				Mean	Food safety knowledge level		
		Always (No.)	%	Sometimes (No.)	%			Never (No.)	%
1	Personal hygiene	197	82.4	42	17.6	0	0.0	2.82 (5.32)	Good
2	Personal hygiene	181	75.7	33	13.8	25	10.5	2.65 (4.84)	Good
3	Personal hygiene	88	36.8	18	7.5	133	55.6	1.81 (2.37)	Fair
4	Food storage	137	57.3	89	37.2	13	5.4	2.52 (4.20)	Good
5	Food storage	62	25.9	156	65.3	21	8.8	2.17 (2.87)	Fair
6	Food thawing	29	12.1	83	34.7	128	53.6	1.59 (1.43)	Poor
7	Leftover food	175	73.2	42	17.6	23	9.6	2.64 (4.76)	Good
8	Reheating food	69	28.9	158	66.1	12	5.0	2.24 (3.07)	Fair
Total of response		938		621		355			
Total percentage		49.1%		32.5%		18.6%			

Mean $3 \geq 2.3$ is considered good level; Mean $2.3 \geq 1.6$ is considered fair level; Mean $1.6 \geq 1.0$ is considered poor level. Standard deviation is indicated between the bracket ().

ering two domains; shopping behavior and cross-contamination were analyzed. Questions 1 to 5 were about the food safety practices during shopping and preparing food at home.

In question 1, about three-quarters (80.8%) of the participants always check food expiration dates, dented, leaking, cracked, or bulging lid of the canned food before purchasing the products. Whereas the rest of them do not check for these defects. Food containers (metal, plastic, carton) observation is essential and gives a perception of the food condition inside. A similar study conducted in Kolkata, India, on teenagers found that most participants were concerned only about the shelf-life or safety of the products by reading the expiration date (Saha *et al.*, 2013). Actually, other studies carried out by St Everald (2002); Verbeke, Frewer, Scholderer, and De Brabander (2007) reported that most participants had paid attention to the products' brand name rather than expiration dates.

In question 2, the majority (75.7%) of studied women always buy meat from butchers who follow personal hygiene practices such as wearing clean clothes, gloves, face masks, and hair cover, compared to 20.5% who do not care about the butcher's practices.

A report carried out by Hall, Wikswo, Pringle, Gould, and Parashar (2014) found that among 520 outbreaks, food handlers were responsible for 70% of the cases. The responsibility of controlling food handlers usually lies with government agencies to ensure that food sector workers follow food safety practices. Both previous questions scored good with means of 2.75 ± 5.14 and 2.72 ± 4.97 , respectively.

Question 3 was about the use of insulated cooler bag while shopping. The majority

of participants (63.2%) never use a cooler bag while shopping, and only about 18% always use it when buying frozen items. This option could not be essential in all parts of the world, where it depends on the ambient temperature. In Saudi Arabia, the temperature could reach 50°C during summer. Thus, a cooler bag could be essential to keep the quality of the frozen items and prevent multiplying microbes during shopping and transferring home. The participants' response scored poor with a mean of 1.55 ± 1.46 .

The following questions, 4 and 5, were about proper frozen product handling during shopping. In question 4, most participants (70%) do not care about the time of buying frozen products during shopping, compared to 16.7% who always buy frozen products just before leaving the supermarket. Such behavior may cause the thawing of frozen products, especially in hot places, resulting in food spoilage. Thus, the question scored fair with a mean of 2.03 ± 2.40 .

In question 5, nearly 62% of participants take ≤ 2 hours to transport frozen products from the supermarket until reaching home. 22.2% take longer (2 to 4 hours). The time spent transporting home frozen products from the supermarket should be minimized, depending on the ambient temperature, time (day or night), and season (winter or summer) to keep frozen products safe. Thus, the responses scored good with a mean of 2.46 ± 4.18 .

The following two questions, 6 and 7 were about cross-contamination occurring during food preparation. Cross-contamination can occur between raw meat and cooked or ready-to-eat food. This could happen when contaminated hands, knives, cutting board are used for raw and cooked food without washing. The majority of the

participants (60.2% and 52.7%) always use the same knives and cutting board respectively, for raw meats and cooked or ready-to-eat food and wash them thoroughly (using a diluted bleach solution) between uses. In comparison, 36% and 42.7% of them always use different knives and cutting boards respectively, for raw meats and cooked food. Therefore, the highest score was given to those who used different knives and cutting boards of raw and cooked food. A study carried out by Parra *et al.* (2014) reported that about 58% of participants sanitized countertops and cutting boards with soap or bleach, while about 40% of them used a different cutting board. Nearly 12% did not properly sanitize countertops or cutting boards.

Despite washing food preparation utensils, using detergent or sanitizer during washing could eliminate some microorganisms. Some types of microbes can form a biofilm which is quite hard to remove, resulting in many problems in food preparing places (Wirtanen & Salo, 2016). Generally, two sets of cutting boards and knives should be kept in the kitchen to prepare ready-to-eat and non-ready-to-eat food products. Cross-contamination can be prevented by separating the utensils used for both types of food. If only one set of cutting boards and knives is available, the ready-to-eat food should be handled first, while the non-ready-to-eat food should be thoroughly cleaned. Both questions scored good with means of 2.32 ± 3.38 and 2.38 ± 3.63 , respectively.

Question 8 was about cleaning the countertops, including, sinks, taps, and drainers, after each use. Three-quarters (75.3%) of participants always wash the countertop area after each use, while 7.9% do not wash it frequently after using it. This

Table 3. The scores of Saudi women's responses to food safety practices questions.

No.	Questions	Response				Mean	Food safety knowledge level		
		Always (No.)	%	Sometimes (No.)	%			Never (No.)	%
1	Shopping behavior	193	80.8	33	13.8	13	5.4	2.75 (5.14)	Good
2	Shopping behavior	181	75.7	49	20.5	9	3.8	2.72 (4.97)	Good
3	Shopping behavior	43	18.0	45	18.8	151	63.2	1.55 (1.46)	Poor
4	Shopping behavior	40	16.7	166	69.5	33	13.8	2.03 (2.40)	Fair
5	Shopping behavior	148	61.9	53	22.2	38	15.9	2.46 (4.18)	Good
6	Cross-contamination	86	36.0	144	60.3	9	3.8	2.32 (3.38)	Good
7	Cross-contamination	102	42.7	126	52.7	11	4.6	2.38 (3.63)	Good
8	Cross-contamination	180	75.3	19	7.9	40	16.7	2.59 (4.70)	Good
Total of response		973	635	304	-	-	-		
Total percentage		50.9%	33.2%	15.9%					

Mean $3 \geq 2.3$ is considered good level; Mean $2.3 \geq 1.6$ is considered fair level; Mean $1.6 \geq 1.0$ is considered poor level. Standard deviation is indicated between the bracket ().

Table 4. The correlation between socio-demographic characteristics of Saudi women living in Al-Ahsa region and their food safety knowledge and practice level.

Variables	Chi-square	P-value	Decision
Age	16.282	0.039	Significant
Marital status	39.553	0.001	Significant
Work status	10.212	0.037	Significant
Educational level	25.937	0.001	Significant
Family size	0.209	0.901	Insignificant
Total income	6.051	0.418	Insignificant

Significant at $\alpha=0.05$ as P value <0.05 .

area can be a source of microbial infection, causing cross-contamination to ready-to-eat food. This question scored good with a mean of 2.59 ± 4.70 .

Overall, most participants were aware of the importance of personal hygiene, prevention of cross-contamination, shopping behavior and handling of leftover food. However, although participants appeared to realize the importance of the most significant food safety practices, including hand washing, they did not always implement them during food preparation. Although some participants knew how to avoid cross-contamination by washing hands, knives, or cutting board, they did not take the extra effort to apply these relevant hygiene measures (Fischer *et al.*, 2007).

The impact of socio-demographic characteristics on the level of food safety knowledge and practices

The effect of socio-demographic characteristics on the level of food safety knowledge and practices among Saudi women living in Al-Ahsa region, using non-parametric tests (Chi-square), is summarized in Table 4. A positive and significant correlation between age and food safety knowledge and practices level was observed ($P < 0.039$). The responses of the age group (40–49) achieved the highest scores (good) and fair. This may be attributed to their experience compared to younger women. A similar study carried out on Saudi mothers revealed that women in the age group 36–50 achieved the highest score in food safety knowledge and practices (Ayaz *et al.*, 2018). The correlation between marital status, food safety knowledge and practice level were significant ($P < 0.001$). Married women achieved the highest level (good and fair) scores compared to singles, separated, and widowed. Moreover, work status is significantly correlated with food safety knowledge and practices ($P < 0.037$). Unemployed participants achieved the highest score (good)

because most participants (54.8%) were unemployed. In addition, the educational level of participants correlated significantly with the level of food safety knowledge and practices ($P < 0.001$). The highest score (good) was achieved by women who held a bachelor's degree (undergraduate); as most participants (47.2%) had bachelor's degree. Evidently, higher food safety knowledge and practices scores were found more in highly educated women than in less educated ones. Education may create appositive knowledge, practicing and awareness among household women and protect household members. Similar study were conducted on household women in Pakistan and Italy and they revealed a strong correlation between high education level and positive food safety knowledge and practicing behavior (Angelillo *et al.*, 2001; Naeem *et al.*, 2018). On the other hand, no significant correlation was observed between family size and total income ($P < 0.910$ and $P < 0.418$ respectively).

Conclusion

This is the first representative survey of the food safety knowledge and practices among Saudi women living in Al-Ahsa region, Saudi Arabia. This study highlighted the food safety knowledge and practice level of the women who are generally responsible for preparing food at home. Although participants had never attended food safety training, the overall findings were satisfactory in most domains. The high knowledge of participants may be attributed to their practical experience and educational level since most were 47.8 years old and held bachelor's degrees. Nevertheless, improper food preparation practices have been noticed, such as using the same cutting boards and utensils for raw and cooked food. These tools may carry serious pathogens causing foodborne illnesses through cross-contamination incidents. Also, thawing frozen meat at room temperature may have a possible risk of bacterial

growth. In addition, mishandling leftover food may lead to serious health risks. The study concludes that there is a need for further research to determine the possible dangers that might happen during food preparation by women as they are generally the primary food preparers at home. Although the findings showed good scores in many domains, introducing food safety courses is recommended for each woman. These courses have to be free of charge to reach all women. This can be done by establishing effective and professional programs. Further research may be needed to cover more households in Al-Ahsa region to understand in depth food safety knowledge, practice, and behavior of household's women to improve food handling at home.

References

- Ahmed WAM, 2015. Mothers' Knowledge Regarding Preventive Measures of Food Poisoning in Yemen. *Food and Nutrition Sciences* 6:49.
- Akhtar S, Khan MI, Faiz F, 2013. Effect of thawing on frozen meat quality: A comprehensive review. *Pakistan Journal of Food Sciences* 23: 198-211.
- Angelillo IF, Foresta MR, Scozzafava C, Pavia M, 2001. Consumers and foodborne diseases: knowledge, attitudes and reported behavior in one region of Italy. *International journal of food microbiology*, 64:161-166.
- Arfaoui L, Mortada M, Ghandourah H, Alghafari W, 2021. Food Safety Knowledge and Self-reported Practices among Saudi Women. *Current Nutrition & Food Science*, 17(8), 891-901.
- Ayad AA, Abdulsalam NM, Khateeb NA, Hijazi MA, Williams LL, 2022. Saudi Arabia household awareness and knowledge of food safety. *Foods*, 11(7), 935.
- Ayaz WO, Priyadarshini A, Jaiswal AK, 2018. Food safety knowledge and practices among Saudi mothers. *Foods*, 7(12), 193.

- Bank W, 2018. Food-Borne Illnesses Cost US \$110 Billion Per Year in Low-and Middle-Income Countries. In: WorldBank Washington, DC, USA.
- Curtis L, 2008. Prevention of hospital-acquired infections: review of non-pharmacological interventions. *Journal of Hospital Infection*, 69(3), 204-219.
- Curtis V, Cairncross S, 2003. Effect of washing hands with soap on diarrhoea risk in the community: a systematic review. *The Lancet infectious diseases*, 3(5), 275-281.
- EFSA, 2011. The European Union summary report on trends and sources of zoonoses, zoonotic agents and foodborne outbreaks in 2009. *EFSA Journal*, 9(3), 2090.
- Ercolini D, Russo F, Torrieri E, Masi P, Villani F, 2006. Changes in the spoilage-related microbiota of beef during refrigerated storage under different packaging conditions. *Applied and environmental microbiology*, 72(7), 4663-4671.
- Farahat MF, El-Shafie MM, Waly MI, 2015. Food safety knowledge and practices among Saudi women. *Food Control*, 47, 427-435.
- Fischer AR, De Jong AE, Van Asselt ED, De Jonge R, Frewer LJ, Nauta MJ, 2007. Food safety in the domestic environment: an interdisciplinary investigation of microbial hazards during food preparation. *Risk Analysis: An International Journal*, 27(4), 1065-1082.
- Hall AJ, Wikswa ME, Pringle K, Gould LH, Parashar UD, 2014. Vital signs: food-borne norovirus outbreaks—United States, 2009–2012. *Morbidity and Mortality Weekly Report*, 63(22), 491.
- Hassan HF, Dimassi H, Karam ZN, 2018. Self-reported food safety knowledge and practices of Lebanese food handlers in Lebanese households. *British Food Journal*.
- Hillers VN, Medeiros L, Kendall P, Chen G, Dimascola S, 2003. Consumer food-handling behaviors associated with prevention of 13 foodborne illnesses. *Journal of food protection*, 66(10), 1893-1899.
- Hoffman S, Macculloch B, Batz M, 2015. Economic burden of major foodborne illnesses acquired in the United States. Retrieved from
- Hui H, 2012. Handbook of meat and meat processing: CRC press.
- Jevšnik M, Ovca A, Bauer M, Fink R, Oder M, Sevšek F. 2013. Food safety knowledge and practices among elderly in Slovenia. *Food Control*, 31(2), 284-290.
- Kagan LJ, Aiello AE, Larson E, 2002. The role of the home environment in the transmission of infectious diseases. *Journal of community health*, 27(4), 247-267.
- Naeem N, Raza S, Mubeen H, Siddiqui SA, Khokhar R, 2018. Food safety knowledge, attitude, and food handling practices of household women in Lahore. *Journal of Food Safety*, 38(5), e12513.
- Osaili TM, Obeidat BA, Jamous DOA, Bawadi HA, 2011. Food safety knowledge and practices among college female students in north of Jordan. *Food Control*, 22(2), 269-276.
- Parra PA, Kim H, Shapiro MA, Gravani RB, Bradley SD, 2014. Home food safety knowledge, risk perception, and practices among Mexican-Americans. *Food Control*, 37, 115-125.
- Redmond EC, Griffith CJ, 2003. Consumer food handling in the home: a review of food safety studies. *Journal of food protection*, 66(1), 130-161.
- Saha S, Vemula SR, Mendu VVR, Gavaravarapu SM, 2013. Knowledge and practices of using food label information among adolescents attending schools in Kolkata, India. *Journal of nutrition education and behavior*, 45(6), 773-779.
- StEverald AM, 2002. Analysis of Consumer Perceptions Toward Biotechnology and Their Preferences for Biotech Food Labels: Louisiana State University and Agricultural & Mechanical College.
- Unusan N, 2007. Consumer food safety knowledge and practices in the home in Turkey. *Food Control*, 18(1), 45-51.
- Usfar AA, Iswarawanti DN, Davelyna D, Dillon D, 2010. Food and personal hygiene perceptions and practices among caregivers whose children have diarrhea: a qualitative study of urban mothers in Tangerang, Indonesia. *Journal of nutrition education and behavior*, 42(1), 33-40.
- Verbeke W, Frewer LJ, Scholderer J, De Brabander HF, 2007. Why consumers behave as they do with respect to food safety and risk information. *Analytica chimica acta*, 586(1-2), 2-7.
- WHO, 2017. The burden of foodborne diseases in the WHO European region.
- Wirtanen G, Salo S, 2016. Biofilm risks. In *Handbook of hygiene control in the food industry* (pp. 55-79): Elsevier.
- Young I, Waddell L, 2016. Barriers and facilitators to safe food handling among consumers: a systematic review and thematic synthesis of qualitative research studies. *PloS one*, 11(12), e0167695.