AMERICAN UNIVERSITY OF BEIRUT

BELIEFS, PRACTICES, AND KNOWLEDGE OF FOOD HANDLERS IN HOUSEHOLDS REGARDING ELECTRICITY OUTAGE EFFECT ON FOOD SAFETY: NATIONAL CROSS-SECTIONAL STUDY IN LEBANON

by
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A thesis
submitted in partial fulfillment of the requirements
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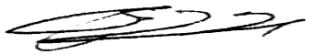

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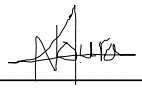

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ABSTRACT
OF THE THESIS OF

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Title: Beliefs, Practices, and Knowledge of Food Handlers in Households Regarding Electricity Outage Effect on Food Safety: National Cross-Sectional Study in Lebanon

Food safety is of a huge concern globally and in developing countries particularly since foodborne illnesses continue to pose a threat to human and animal life, thereby affecting their quality of life. Massive research has been conducted to understand the causes and mechanisms of these diseases in order to reduce morbidity and mortality rates that are food related.

The purpose of this study was to assess the consumer's food safety knowledge, beliefs and practices in households during electricity cut-off. A cross-sectional study among consumers in Lebanon was conducted. Data was collected online using AUBlime survey. A total of 571 consumers from all over the country completed the survey and were included in the analysis.

Results confirmed that food handlers and consumers in Lebanon had unsatisfactory food safety knowledge level (mean score was 10 ± 4.112 (< 11, which is the 70% of the total knowledge score ranging from 0 to 15) along with poor food safety beliefs (mean belief score was $2.77 \pm 1.372 < 4$, which is the 70% of the total belief score ranging from 0 to 4) and practices (mean practice score was 10.79 ± 2.451 (< 14, which is the 70% of the total practice score ranging from 0 to 20). The results also showed that age, governorate, educational level, and self-reported food safety knowledge score were significantly associated with good knowledge score.

The study indicated major gaps in knowledge, beliefs, and practices of participants in Lebanon towards food safety especially during electricity outage. Planned and constructed efforts are needed to improve the education of participants on food safety in order to reduce the risk of foodborne illnesses in Lebanon.

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CHAPTER I

INTRODUCTION AND LITERATURE REVIEW

Despite numerous scientific and technological efforts, food and waterborne illnesses continue to be a threat to humans and economy. This issue can be noticed all over the world and especially in developing countries (Todd, 2020). Many challenges are predicted to compromise the global system in providing safe food and water. Some of them are being observed now in different regions, such as environmental changes (climate, and water scarcity), population growth and consumer demands, food production changes, emergence of new pathogens and contaminants especially antibiotic resistance, and economic crises (Havelaar et al., 2010; CDC, 2020).

With all the knowledge that people acquired in the field of food safety, there's still a major gap due to insufficiency of awareness among populations regarding the safety of the food, especially that food can be contaminated at any stage of the food chain from receiving to consumption and can result in a serious risk of foodborne diseases (Havelaar, et al., 2010). The main agent of serious and deadly foodborne diseases is related to bacteria "Of the many thousands different bacterial species, more than 90% of food-poisoning illnesses are caused by species of *Staphylococcus, Salmonella, Clostridium, Campylobacter, Listeria, Vibrio, Bacillus,* and *Enteropathogenic Escherichia coli*" (Khairuzzaman, et al., 2014).

Lebanon is in critical situation due to many crises that this country has been through. Starting with the civil war to the current economic recession, through the political insecurity, increasing number of refugees, and the COVID – 19 pandemics, all

affecting food sector both ways, as quantity and quality (*World report 2021: RIGHTS trends in Lebanon* 2021). Moreover, a lack of public water supply in Lebanon might drive households to make tough decisions about their basic water, sanitation, and hygiene requirements which can lead to an increase in diseases rate and might affect their food handling. (UNICEF, 2021)

In Lebanon, food and water-related outbreaks are only detected if "spaciotemporal clusters" are confirmed or if the history of exposure reveals common consumed meals. Thus, distributed outbreaks are not accounted for and are mostly hidden by the endemicity of the illness. (Fadlallah et al., 2019) Contamination of food can happen at any stage of the food chain including food preparation. This stage involves the action of food handlers which is considered one of the reasons behind foodborne diseases. (Tappes et al., 2020)

In some countries, homes account for the highest percentage of foodborne illness outbreaks. Analysis of data from scientific articles dealing with foodborne outbreaks in Brazil (2000-2018), recognized households as the most frequent location of foodborne illnesses occurrence (45.6%) (Finger, et al., 2019). Within the European Union, 36.4% of reported outbreaks were accounted for households. (EFSA, 2011)

Foodborne acute gastroenteritis is linked to improper food handling practices in households including infrequent complete heating, poor food storage, cross contamination, and infected food handlers. (Scott, 2003) This can be accelerated by long electricity outage which renders the storage of high risk food and making it even harder to control food poisoning, since bacteria can develop rapidly when these perishable food are left within the temperature danger zone (5ºC - 60 ºC) and can reach dangerous levels if kept more than 2 hours. (Nasser, 2021) For instance, Langiano et al.,

(2012) stated that inadequate understanding of foodborne illnesses and pathogens was found among families in Italy. Poor hygienic practices were also observed during preparation and storage of food. (Langiano et al., 2012)

A study in Lebanon indicated that there is a lack of food safety awareness among young participants regarding many practices and attitudes such as cross contamination, cooking, thawing and prevention procedures (Hassan & Dimassi, 2013). According to Hassan et al., only 35.8% of Lebanese food handlers knew that freezing the food can't kill bacteria, and 54.5% agreed on placing the prepared food in fridge and reheating the food if not consumed within three hours. The study affirmed the need of further educational and awareness campaigns for food handlers. (Hassan et al., 2018) In times of emergency, like electricity cut-off, not only quality and safety of food is affected but also the dietary habits and food choices. (Caswell, 2013) People will experience shortage of money to buy nutritious food and equipment to store high risk foods in their own house.

There are nine agencies that govern the food safety in Lebanon. The lack of coordination among these agencies and the lack of accountability have affected the efficiency of controlling the safety and quality of food products in the country. These agencies have no clear food safety law, no schedule for regular food inspections, and ineffective control of the microbiological and chemical hazards. Mostly, the lack of awareness of many food businesses in Lebanon is jeopardizing public health and escalating the poor food safety situation in the country (El-Jardali et al., 2014; Ghaida et al., 2014).

Another critical issue in Lebanon is water contamination affecting the quality of irrigation and agriculture products (Faour-Klingbeil, 2017). Many Lebanon's rivers,

including the main one, the Litani River, and groundwater, are polluted with untreated sewage and leaks from unregulated dumpsites (MoE, 2001). Notably, a study in 2019 detected 22 mcr-1 positive *E.coli* in irrigation water samples that were gathered in two of the major agricultural regions in the country (South Lebanon and the Beqaa Valley). All isolates were resistant to penicillin, ampicillin, and tetracycline (Hmede et al., 2019). Moreover, in 2015 after studying the microbial safety of lettuce, parsley and radish that were obtained mainly from Bekaa Valley and other lands via their related stores, it was confirmed an increase in *Escherichia coli* content after harvesting and during transportation along with the presence of *Staphylococcus aureus, Listeria monocytogenes* and *Salmonella spp* in these raw vegetables (Faour-Klingbeil et al., 2015). This can emphasize that ready to eat like fruits and vegetables are a source of contamination and can cause foodborne illness.

The data on food safety knowledge among consumers during emergencies of power outage is scarce. To date one study was conducted in United States to assess the preparedness and understanding of the populations towards food safety when there is no electricity. They found that only 15% of the subjects were totally prepared and aware how to keep the food safe (Kosa, et al., 2011).

In Lebanon, all these factors require a serious attention especially with the recent increase in the food poisoning cases during electricity cut-off (MoPH, 2021). Therefore, our aim in the present study is to assess the beliefs, practices and knowledge related to electricity outage effect on food safety among food handlers in households in Lebanon, and to investigate the socio-demographic determinants of knowledge related to electricity outage effect on food safety among study participants, in order to control foodborne illnesses and ensure the safety of consumed food.

CHAPTER II

METHODS AND MATERIALS

A. Study Setting and Population:

Descriptive cross-sectional study was conducted online among Lebanese people and residents in Lebanon whom are at least 18 years old. Sample size calculation was done using World Health Organization (WHO) sample size calculator that showed a minimum of 384 respondents ought to be recruited in order to estimate a prevalence of 50% with a 95% CI and a margin of error 5%. In order to account for a 20% refusal rate, 576 respondents were then selected for the study.

An online invitation (Appendix 1) was sent out via social media (WhatsApp groups, Facebook pages, Instagram) where participants were invited to the research. Before starting the questionnaire, a consent form (Appendix 2) appeared on their screen where they could read and download. After that, once agreed to take part in the study, they proceed in filling the survey (Appendix 3).

B. Data Collection:

The study was reviewed and approved by the Institutional Review Board (IRB) at AUB. Data collection was completed using AUB Limesurvey between February and April 2022. Participant's identity was completely anonymous; no name or any other personal information was recorded.

All students' researchers and other members of the research team have CITI certification for human subjects' research according to AUB IRB regulations prior the initiation of the study. Participants were informed that their participation is completely

voluntarily and their refusal or withdrawal will not affect their relationship with AUB. There will be no risks or direct benefits arising from participating in this study.

C. Questionnaire:

Due to social restrictions caused by COVID – 19 pandemic situation, the study was conducted online. The questionnaire was based on similar previous studies (Kosa, et al., 2011; Hassan et al., 2018; El Haddad, et al., 2020). However, Modifications were applied to assess the population knowledge and practices during electricity cut-off such as using recommendations published by United States Department of Agriculture, Centers for Disease Control and Prevention, and Food Safety Government in United Sates, (USDA, 2017; CDC, 2020; Food Safety.gov, 2021). Moreover, before conducting the study, the questionnaire was reviewed by experts in the food science and food safety field.

The survey was divided into 5 sections. The first section included questions related to their socio demographic characteristics such as age, gender, area of residency, educational level and the total income. The second section was composed of basic questions related to food and water safety in households. The third section was related to knowledge about food safety. The fourth section was related to the attitudes towards the risks associated with food safety. Last section included questions practices that could increase the risk of food poisoning. The completion of the questionnaire should take approximately 10 minutes. Before proceeding with the survey and sending it to the public, a pre-testing was conducted where the survey was sent to 15 individuals to validate the questionnaire and to uncover any possible problems within the survey. However, those 15 responses were not included in the analysis.

D. Statistical Analysis:

The results obtained were statistically analyzed using the Statistical Package for the Social Sciences version (SPSS) 26.0. Complete responses have only been used for the analysis. For the summary of the data, descriptive statistics were used. Frequencies and proportions were used for categorical variables. Chi square was used to study the association between participant's characteristics (gender, educational level, age…) and their awareness and knowledge towards electricity outage effect on food safety. Moreover, a regression analysis was done to determine the predictor variables for consumer's beliefs, practices and knowledge level. Each multiple choice question was giving one point for the correct answer and zero points for the wrong answer and "I don't know" answer. Resulting in knowledge score ranging from 0 to 15, practices score ranging from 0 to 20, and beliefs score ranging from 0 to 6. Participants with knowledge, beliefs, and practices scores below 70% were considered to have low levels, whereas those with scores ≥ 70% were considered to have high levels (Soares et.al, 2012). The socio-demographic characteristics represented the independent variables. Whereas total knowledge, belief, and practice score ratings represented the dependent variables. A p-value of 0.05 was considered significant

CHAPTER III

RESULTS

A. Participants Socio-Demographic Characteristics:

The study population included a total of 571 complete responses after the exclusion of incomplete responses. The demographic characteristics of the participants are presented in (Table 1). The sample consisted of 60.9% (348) female and 39.1% (223) male. The sample age groups were ranging from 18 years old to 60 years old and more. The biggest participation percentage was accounted to the youngest group (18 – 29) with 52.5%. More than half of the respondents were single (57.4%), 38.9% were married, and 3.8% were divorced, widowed, or separated. Almost 49% of the respondents were residing in Mount Lebanon, whereas, 28.9%, 9.8%, 8.4%, and 4.0% resided in Beirut, South, North, and Bekaa respectively. However, 70.8% of the participants reported having university degree whether it's bachelor, master, or PhD. For the households' income, 57.8% claimed that the monthly income was less than 10,000,000 L.L. whereas, 42.2% responded with an income more than 10,000,000 L.L. (Table 1). The respondents rated their food safety knowledge as excellent (16.6%), good (68.1) or weak (15.2%) (Table 1)

Table 1. Socio-demographic characteristics of participants

Demographic Characteristic	Variables	Percentage (%)	Frequency (N)
Age	18 – 29	52.5	300
	30 – 39	27.3	156
	40 – 49	11.4	65
	50 – 59	6.7	38

	60 and more	2.1	12
Gender	Female	60.9	348
	Male	39.1	223
Marital Status:	Single	57.4	328
	Married	38.9	222
	Divorced, Widowed, and Separated	3.8	21
Governorate of Lebanon	Mount Lebanon	48.9	279
	Beirut	28.9	165
	South	9.8	56
	North	8.4	48
	Bekaa	4.0	23
Nationality	Lebanese	91.8	524
	Non Lebanese	8.2	47
Educational Level	School certificate	24.5	140
	University bachelor	47.3	270
	Master/PhD	23.5	134
	Technical school	4.7	27
Total Household Income	Less than 1,000,000 LL	2.3	13
	1,000,000 – 5,000,000	22.9	131
	5,000,000 – 10,000,000	32.6	186
	More than 10,000,000	42.2	241
How do you rate your food safety knowledge?	Excellent	16.6	95
	Good	68.1	389
	Weak	15.2	87

B. Basic Questions Related to Food Safety in Household:

Questions were asked to investigate whether the participants are food handlers or if they are experiencing electricity outage (Table 2). The results showed that 45.9% and 72.7% were the primary food handler or involved in food preparation, respectively. Since Lebanon has an electricity issue, participants were asked if they are facing this problem at their houses. Only 6% answered that they don't experience electricity outage and 94% experiencing at least 2 hours of electricity cut-off per day (Table 2). Out of

571, a total of 339 (59.4%) reported that they don't check the temperature of their fridges/freezers during the day.

Furthermore, 54.1% of the participants had diarrhea, vomiting, fever or abdominal pain in the past 6 months, whereas 65.3% affirmed that they know people whom got food poisoning and 78.6% whom experienced diarrhea, vomiting, fever or abdominal pain in the past 6 months. However, 13.8% claimed that they were hospitalized because of a food poisoning (Table 2). Regarding the consumption of meat, 36% of the participants eat their meat cooked medium – rare or rare (Table 2). However, 65.1% of the respondents shifted from ordering undercooked meat to well-done meat (Table 3). A question was asked to determine the type of food that people are afraid to consume outside the house. 53.1% of the participants were afraid to eat a specific type of food giving the largest percentage of 36.3% of respondents were afraid to consume sushi (Table. 3 Beliefs). During electricity cuts and due to the inability to refrigerate the food properly, a total of 424 participants (74.3%) did change their perishable food storage habits (Table 3).

Table 2. Basic questions related to food safety

Question statement	Variables	Percentage (%)	Frequency (N)
Are you the primary food handler in your household?	Yes	45.9	262
	No	54.1	309
Are you involved in food preparation at your house?	Yes	72.7	415
	No	27.3	156
How many hours per day do you experience electricity cut-off at your house?	I don't experience electricity cut off	6.0	34
	Less than 2 hours	4.0	23
	2 – 4 hours	13.3	76
	More than 4 hours	76.7	438

How often do you check the temperature of your fridge/freezer?	Once/day Twice/day More than 3 times/day I don't check it	22.1 10.5 8.1 59.4	126 60 46 339
Did you experience diarrhoea, vomiting, fever, or abdominal pain in the past 6 months	Yes No	54.1 45.9	309 262
Have you been hospitalized because of food poisoning in the past 6 months	Yes No	13.8 86.2	79 492
Do you know anyone (other than yourself) who got food poisoning in the past 6 months?	Yes No	65.3 34.7	373 198
Do you know anyone (other than yourself) who experienced diarrhoea, vomiting, fever, or abdominal pain in the past 6 months?	Yes No	78.6 21.4	449 122
How do you usually eat your meat?	Well done Medium – rare Rare I don't eat meat	59.9 29.2 6.8 4.0	342 167 39 23

Table 3. Basic questions related to food safety during electricity cut-off

Question statement	Variables	Percentage (%)	Frequency (N)
With the electricity cutoff and with the increase of food poisoning cases in Lebanon, did you shift from ordering medium-rare meat to order well done meat?	Yes No	65.1 34.9	372 199
What food are you afraid the most to eat from outside you house (restaurant) during electricity cut off?	Burgers/sandwiches Sushi Salads Everything Nothing	8.6 36.3 8.2 31.9 15.1	49 207 47 182 86
Did the electricity cuts change your perishable	Yes No	74.3 25.7	424 147

food (foods that need refrigerator: meat, chicken, dairy) storage habits?

C. Food Safety Knowledge among Participants:

The overall food safety knowledge score was the result of adding all the correct answers. The mean food safety knowledge score was 10 ± 4.112 (< 11, which is the 70% of the total knowledge score ranging from 0 to 15) resulting insufficient food safety knowledge among the participants in Lebanon. More than half (52.7%) of the participants scored poor food safety knowledge and 47.3% scored good knowledge. Table 5 presents some of the questions that were asked regarding food safety knowledge. 65.1% agreed that food poisoning can happen as result of consuming contaminated food only if it's consumed the same day or the day before. Regarding the optimal temperature of freezer and refrigerator, 56.7% and 51.3%, respectively, of the participants didn't know or they answered wrongly to these questions. When more advanced questions were asked regarding specific types of bacteria, 63.7%, 79.2%, 69.9%, and 64.3%, respectively, didn't know what is Escherichia coli, Campylobacter, Listeria, and Staphylococcus aureus. However, 64.3% of the respondents knew what Salmonella is (Table 4).

Table 4. Knowledge regarding different bacteria

Question Statement	Response	Percentage (%)	Frequency (N)
Do you know what Escherichia Coli is?	Yes	36.3	207
	No	63.7	364
Do You know what Campylobacter is?	Yes	20.8	119
	No	79.2	452
Do You know what Listeria is?	Yes	30.1	172
	No	69.9	399

Do You know what Salmonella is?	Yes	83.9	479
	No	16.1	92
Do You know what Staphylococcus aureus is?	Yes	35.7	204
	No	64.3	367

Table 5. Score distribution of food safety knowledge questions

Question Statement	Correct answer	Wrong answer
Do you know that foodborne pathogens can multiply on food that was not refrigerated?	69.9% (399)	30.1% (172)
Food poisoning can happen as a result of consuming contaminated food on the same day or the day before only	34.9% (199)	65.1% (372)
If smell and color of food seem okay, that means the food is not contaminated	58.3% (333)	41.7% (238)
Storing raw chicken in the fridge without proper precaution can contaminate other food	71.5% (408)	28.5% (163)
What is the optimal temperature of frozen food?	43.3% (247)	56.7% (324)
What is the optimal temperature of fridge?	48.7% (278)	51.3% (293)
Is freezing enough to eliminate foodborne bacteria and viruses?	59.5% (340)	40.5% (231)
Choose the best way to reduce the risk of contaminated food (Cooking, washing the food, refrigeration, don't know)	59.2% (338)	40.8% (233)

The association between the socio-demographic characteristics and food safety knowledge among the subjects were described in table 6. Results showed that the association is statistically significant between the knowledge score and the following socio-demographics characteristics; age, residing area (governorate of Lebanon), nationality, educational level, food safety knowledge rating, and the frequency of checking the temperature of fridge during electricity outage.

Table 6. The association between socio-demographic characteristics and other explanatory factor with food safety knowledge score among participants

Variables	**Good Knowledge n(%)**	**Poor Knowledge n(%)**	**Total (n=571)**	**Significance**
Age group				**P = 0.000**
18 – 29	158 (52.7%)	142 (47.3%)	300	**X^2= 24.762**

30 – 39	77 (49.4%)	79 (50.6%)	156	
40 – 49	27 (41.5%)	38 (58.5%)	65	
50 – 59	5 (13.2%)	33 (86.8%)	38	
60 and more	3 (25.0%)	9 (75.0%)	12	
Gender				P = 0.194
Female	157 (45.1%)	191 (54.9%)	348	X^2= 1.684
Male	113 (50.7%)	110 (49.3%)	223	
Marital Status				P = 0.147
Single	166 (50.6%)	162 (49.4%)	328	X^2= 6.790
Married	98 (44.1%)	124 (55.9%)	222	
Divorced	5 (38.5%)	8 (61.5%)	13	
Widowed	1 (16.7%)	5 (83.3%)	6	
Separated	0 (0.00%)	2 (100%)	2	
Governorate of Lebanon				**P = 0.000** **X^2= 31.112**
Beirut	74 (44.8%)	91 (55.2%)	165	
South	13 (23.2%)	43 (29.5%)	56	
North	16 (33.3%)	32 (66.7%)	48	
Mount Lebanon	160 (57.3%)	119 (42.7%)	279	
Bekaa	7 (30.4%)	16 (69.6%)	23	
Nationality				**P = 0.028**
Lebanese	255 (48.7%)	269 (51.3%)	524	**X^2= 4.854**
Non Lebanese	15 (31.9%)	32 (68.1%)	47	
Educational Level				**P = 0.000**
School (Primary, Middle, High)	48 (34.3%)	92 (65.7%)	140	**X^2= 25.767**
Bachelor degree	121 (44.8%)	149 (55.2%)	270	
Master/PhD	83 (61.9%)	51 (38.1%)	134	
Technical school	18 (66.7%)	9 (33.3%)	27	
Household Income				P = 0.494
< 1,000,000 L.L	6 (46.2%)	7 (53.8%)	13	X^2= 2.396
1,000,000 – 5,000,000 L.L	66 (50.4%)	65 (49.6%)	131	
5,000,000 – 10,000,000 L.L	93 (50%)	93 (50%)	186	
>10,000,000 L.L	105 (43.6%)	136 (56.4%)	241	
Are you the **primary food handler** in your household?				P = 0.096 X^2= 2.766
Yes	114 (43.5%)	148 (56.5%)	262	
No	156 (50.5%)	153 (49.5%)	309	
How do you rate your **food safety knowledge**?				**P = 0.000** **X^2= 94.107**
Excellent	77 (81.1%)	18 (18.9%)	95	
Good	185 (47.6%)	204 (52.4%)	389	
Weak	8 (9.2%)	79 (90.8%)	87	

Checking the temperature of fridge/freezer			**P = 0.000** X^2**= 40.576**
I don't check it	128 (37.8%)	211 (62.2%)	
Once/day	67 (53.2%)	59 (46.8%)	
Twice/day	38 (63.3%)	22 (36.7%)	
> 3 times/day	37 (80.4%)	9 (19.6%)	

Table 7 presents the simple and multiple logistic regression analysis for the associations of the socio-demographic characteristics with the likelihood of having good level of knowledge being the dependent variable. Using results from the simple logistic regression, variables significantly associated with the likelihood to have good level of knowledge in the study population included age, governorate, nationality, educational level, self-rating of food safety knowledge, and frequency of checking the temperature of fridges

A multiple logistic regression model was used to examine the associations of the socio-demographic characteristics with the likelihood of having good level of knowledge in the study population (Table 7). Variables were put in the model in order of strength of their association with likelihood of having good level of knowledge as per the simple analysis. The effect of each variable on the model was assessed and the variable was kept if it significantly contributed to a better fit of the model. The final multiple logistic model included the following variables: age, governorate, educational level, self-rating of food safety knowledge, and frequency of checking the temperature of fridges.

Results showed that subjects with age range of 50 – 59, were less likely to have a good knowledge score when compared to subjects with age group of 18 -29 (OR = 0.106, CI: 0.035, 0.318). Moreover, participants residing in Mount Lebanon were 1.935

more likely to obtain a positive knowledge score when compared to those who live in Beirut (OR = 1.935, CI: 1.234, 3.036). Regarding educational level impact on knowledge score, respondents whom achieved master or PhD degree (OR = 2.089, CI: 1.141, 3.825), as their highest educational level, were 2.089 more likely to score a good knowledge score compared to the people whom finished only school (primary, middle, high).

Furthermore, subjects whom claimed to have a good food safety knowledge were less likely to obtain positive knowledge than respondents whom reported to have excellent knowledge level (OR = 0.236, CI: 0.127, 0.441). Subjects whom stated to have weak food safety knowledge were also less likely to present a positive knowledge when compared to the same group of people who claimed to have excellent knowledge level (OR = 0.030, CI: 0.011, 0.078). Those who check the temperature of their fridge/freezer more than three times per day were 3.318 more likely to score a positive belief score than those who don't check the temperature at all.

Table 7. Logistic regression analysis for the association between socio-demographic characteristics and other explanatory factor with the likelihood of having good knowledge score

Variables	**Simple logistic regression OR 95% CI**	**Multiple logistic regression OR 95% CI**
Age group		
18 – 29	1 (Reference)	1
30 – 39	0.876 (0.595, 1.290), p=0.503	0.896 (0.568, 1.413), p=0.636
40 – 49	0.639 (0.371, 1.099), p=0.105	0.722 (0.381, 1.368), p=0.318
50 – 59	**0.136 (0.052, 0.358), p=0.000**	**0.106 (0.035, 0.318), p=0.000**
60 and more	0.300 (0.080, 1.128), p=0.075	0.293 (0.071, 1.204), p=0.089
Gender		
Female	1 (Reference)	
Male	1.250 (0.892, 1.750), p=0.195	
Marital Status		
Single	1 (Reference)	
Married	0.771 (0.548, 1.086), p=0.137	

Divorced	0.610 (0.195, 1.904), p=0.395	
Widowed	0.195 (0.023, 1.689), p=0.138	
Separated	0.000 (0.000), p=0.999	
Governorate of Lebanon		
Beirut	1 (Reference)	1
South	**0.372 (0.186, 0.743), p=0.005**	0.633 (0.286, 1.399), p=0.259
North	0.615 (0.313, 1.206), p=0.157	0.638 (0.282, 1.442), p=0.280
Mount Lebanon	**1.653 (1.122, 2.437), p=0.011**	**1.935 (1.234, 3.036), p=0.004**
Bekaa	0.538 (0.210, 1.377), p=0.196	0.555 (0.186, 1.651), p=0.290
Nationality		
Lebanese	1 (Reference)	1
Non Lebanese	**0.494 (0.262, 0.935), p=0.030**	0.799 (0.378, 1.688), p=0.556
Educational Level		
School (Primary, Middle, High)	1 (Reference)	1
Bachelor degree	**1.556 (1.019, 2.377), p=0.041**	1.044 (0.623, 1.750), p=0.869
Master/PhD	**3.119 (1.905, 5.109), p=0.000**	**2.089 (1.141, 3.825), p=0.017**
Technical school	**3.833 (1.601, 9.177), p=0.003**	2.643 (0.929, 7.520), p=0.069
Household Income		
< 1,000,000 L.L	1 (Reference)	
1,000,000 – 5,000,000 L.L		
5,000,000 – 10,000,000 L.L	1.185 (0.378, 3.715), p=0.771	
>10,000,000 L.L	1.167 (0.378, 3.603), p=0.789	
	0.901 (0.294, 2.760), p=0.855	
Are you the **primary food handler** in your household?		
Yes	1 (Reference)	
No	1.324 (0.951, 1.843), p=0.097	
How do you rate your **food safety knowledge**?		
Excellent	1 (Reference)	1
Good	**0.212 (0.122, 0.368), p=0.000**	**0.236 (0.127, 0.441), p=0.000**
Weak	**0.024 (0.010, 0.058), p=0.000**	**0.030 (0.011, 0.078), p=0.000**
Checking the temperature of fridge/freezer		
I don't check it	1 (Reference)	1
Once/day	**1.872 (1.238, 2.829), p=0.003**	1.603 (0.988, 2.600), p=0.056
Twice/day	**2.847 (1.612, 5.030), p=0.000**	1.368 (0.702, 2.665), p=0.358
> 3 times/day	**6.777 (3.167, 14.503), p=0.000**	**3.318 (1.412, 7.797), p=0.006**

D. Beliefs Towards the Risks Associated with Food Safety:

The overall food safety beliefs score was the result of adding all the correct answers. The mean food safety belief score was 2.77 ± 1.372 (< 4, which is the 70% of the total belief score ranging from 0 to 6) resulting unacceptable food safety beliefs among the participants in Lebanon. Almost 507 (88.8%) of the participants scored poor food safety beliefs and 64 (11.2%) scored good beliefs. About 71.3% of the respondents limited their visits to restaurants because of fear from getting food poisoning. However, 57.1% of the participants strictly ate at home since they belief that food is stored safely (Table 8).

Moreover, 54.1% of the subjects they believe that being vegan or vegetarian now in Lebanon can limit the exposure to food poisoning since some fruits and vegetables don't need to be refrigerated as much as meat and chicken (Table 8).

Table 8. Beliefs towards eating/purchasing habits during electricity cut-off

Question Statement	Response	Percentage (%)	Frequency (N)
During the electricity crises, did you limit your visits to restaurants for fear of getting food poisoning?	Yes No	71.3 28.7	407 164
During the electricity crises, did you strictly eat at home because you know that food has been safely stored (frozen/refrigerated)?	Yes No	57.1 42.9	326 245
Do you use big chain supermarkets instead of small local groceries for purchasing high risk food (dairy, meat, chicken..) since they are safer due to electricity crises?	Yes No	71.8 28.2	410 161
Do you believe that being vegan or vegetarian now in Lebanon will reduce the chance of getting food poisoning?	Yes No	54.1 45.9	309 262

As shown in table 9, 55.2% of the responses were whether wrong or I don't know regarding how long can fridge keep the food safe when there is an extended electricity outage. Only 44.8% knew that food can stay safe to consume inside the fridge for 4 hours. Furthermore, 65.3% of the participants they belief that they can decide if food is cooked enough whether by experience (smelling and tasting food), or visual appearance (color of food), or simply they didn't know.

Table 9. Score distribution of food safety beliefs questions

Question Statement	Correct answer	Wrong answer
During a long electricity cut-off, for how long do you think the fridge will keep the food safely cool?	44.8% (256)	55.2 (315)
During a long electricity cut-off, for how long do you think ta full-packed freezer will keep the food safely frozen?	25.2% (144)	74.8% (427)
During a long electricity cut-off, for how long do you think ta half-packed freezer will keep the food safely frozen?	46.2% (264)	53.8% (307)
How do you know if food is cooked enough?	34.7% (198)	65.3% (373)

Table 10 describes the association of socio-demographic characteristics and other factors with food safety beliefs among participants, highlighting that the association is statistically significant between the beliefs score and age, household income, food safety knowledge rating, and checking the temperature of fridge and/or freezer.

Table 10. The association between socio-demographic characteristics and other explanatory factors with food safety beliefs score among participants

Variables	**Good Knowledge n(%)**	**Poor Knowledge n(%)**	**Total (n=571)**	**Significance**
Age group				**P = 0.045**

18 – 29	39 (13%)	261 (87%)	300	**X^2= 9.744**
30 – 39	21 (13.5%)	135 (86.5%)	156	
40 – 49	4 (6.2%)	61 (93.8%)	65	
50 – 59	0 (0.00%)	38 (100%)	38	
60 and more	0 (00.0%)	12 (100%)	12	
Gender				P = 0.787
Female	40 (11.5%)	308 (88.5%)	348	X^2= 0.073
Male	24 (10.8%)	199 (89.2%)	223	
Marital Status				P = 0.591
Single	39 (11.9%)	289 (88.1%)	328	X^2= 2.805
Married	25 (11.3%)	197 (88.7%)	222	
Divorced	0 (0.00%)	13 (100%)	13	
Widowed	0 (0.00%)	6 (100%)	6	
Separated	0 (0.00%)	2 (100%)	2	
Governorate of Lebanon				P = 0.811 X^2= 1.586
Beirut	17 (10.3%)	148 (89.7%)	165	
South	6 (10.7%)	50 (89.3%)	56	
North	6 (12.5%)	42 (87.5%)	48	
Mount Lebanon	34 (12.2%)	245(87.8%)	279	
Bekaa	1 (4.3%)	22 (95.7%)	23	
Nationality				P = 0.541
Lebanese	60 (11.5%)	464 (88.5%)	524	X^2= 0.375
Non Lebanese	4 (8.5%)	43 (91.5%)	47	
Educational Level				P = 0.722
School (Primary, Middle, High)	12 (8.6%)	128 (91.4)	140	X^2= 1.329
Bachelor degree	33 (12.2%)	237 (87.8%)	270	
Master/PhD	16 (11.9%)	118 (88.1%)	134	
Technical school	3 (11.1%)	24 (88.9%)	27	
Household Income				**P = 0.024**
< 1,000,000 L.L	2 (15.4%)	11 (84.6%)	13	**X^2= 9.400**
1,000,000 – 5,000,000 L.L	13 (9.9%)	118 (90.1%)	131	
5,000,000 – 10,000,000 L.L	31 (16.7%)	155 (83.3%)	186	
>10,000,000 L.L	18 (7.5%)	223 (92.5%)	241	
Are you the **primary food handler** in your household?				P = 0.664 X^2= 0.189
Yes	31 (11.8%)	231 (88.2%)	262	
No	33 (10.7%)	276 (89.3%)	309	
How do you rate your **food safety knowledge**?				**P = 0.000** **X^2= 16.256**
Excellent	20 (21.1%)	75 (78.9%)	95	
Good	42 (10.8%)	347 (89.2%)	389	
Weak	2 (2.3%)	85 (97.7%)	87	

Total **hours of electricity cut off** experienced per day in households				P = 0.065 X^2= 7.221
>4 hours	45 (10.3%)	393 (89.7%)	438	
2- 4 hours	15 (19.7%)	61 (80.3%)	76	
<2 hours	1 (4.3%)	22 (95.7%)	23	
I don't experience electricity cut off	3 (8.8%)	31 (91.2%)	34	
Checking the temperature of fridge/freezer				**P = 0.000** **X^2= 26.716**
I don't check it	24 (7.1%)	315 (92.9%)	339	
Once/day	14 (11.1%)	112 (88.9%)	126	
Twice/day	17 (28.3%)	43 (71.7%)	60	
> 3 times/day	9 (19.6%)	37 (80.4%)	46	

The data presented in table 11 demonstrates the association between different explanatory factors (age, gender, household income, checking the temperature of fridge/freezer, rating food safety knowledge...) and having a positive belief score.

Significant difference was observed regarding self-rating food safety knowledge since respondents whom reported to have weak knowledge, were 0.166 less likely to obtain a positive belief score than respondents with excellent rating knowledge (p = 0.022). Total hours of electricity outage during the day showed a significant difference also. Higher odds of having good belief score were observed among participants who are experiencing 2 – 4 hours of electricity cut-off when compared to those whom facing outage of more than 4 hours (OR = 2.419, CI: 1.219, 4.800). Moreover, those who check the temperature of their fridge/freezer two times and more than three times per day were 3.987 and 2.895, respectively, more likely to score a positive belief score than those who don't check the temperature at all.

Table 11. Logistic regression analysis for the association between socio-demographic characteristics and other explanatory factors with the likelihood of having positive belief score

Variables	**Simple logistic regression OR 95% CI**	**Multiple logistic regression OR 95% CI**
Age group		
18 – 29	1 (Reference)	
30 – 39	1.041, (0.589, 1.840) p=0.890	
40 – 49	0.439, (0.151, 1.274) p=0.130	
50 – 59	0.000, (0.000) p=0.998	
60 and more	0.000, (0.000) p=0.999	
Gender		
Female	1 (Reference)	
Male	0.929 (0.543, 1.588), p=0.787	
Marital Status		
Single	1 (Reference)	
Married	0.940 (0.551, 1.604), p=0.821	
Divorced	0.000 (0.000), p=0.999	
Widowed	0.000 (0.000), p=0.999	
Separated	0.000 (0.000), p=0.999	
Governorate of Lebanon		
Beirut	1 (Reference)	
South	1.045 (0.390, 2.796), p=0.931	
North	1.244 (0.461, 3.353), p=0.666	
Mount Lebanon	1.208 (0.652, 2.239), p=0.548	
Bekaa	0.396 (0.050, 3.123), p=0.379	
Nationality		
Lebanese	1 (Reference)	
Non Lebanese	0.719 (0.249, 2.075), p=0.542	
Educational Level		
School (Primary, Middle, High)	1 (Reference)	
Bachelor degree	1.485 (0.741, 2.975), p=0.264	
Master/PhD	1.446 (0.657, 3.184), p=0.359	
Technical School	1.333 (0.350, 5.083), p=0.673	
Household Income		
< 1,000,000 L.L	1 (Reference)	
1,000,000-5,000,000 L.L	0.606 (0.121, 3.037), p=0.542	
5,000,000-10,000,000 L.L	1.100 (0.232, 5.210), p=0.904	
> 10,000,000 L.L	0.444 (0.091, 2.158), p=0.314	
Are you the **primary food handler** in your household?		

Yes	1 (Reference)	
No	0.891 (0.529, 1.499), p=0.664	
How do you rate your **food safety knowledge**?		
Excellent	1 (Reference)	1
Good	**0.454 (0.252, 0.817), p=0.008**	0.695 (0.367, 1.316, p=0.264
Weak	**0.088 (0.020, 0.390), p=0.001**	**0.166 (0.036, 0.774), p=0.022**
Total **hours of electricity cut off** experienced per day in households		
>4 hours	1 (Reference)	1
2- 4 hours	**2.148 (1.128, 4.087), p=0.020**	**2.419 (1.219, 4.800), p=0.012**
<2 hours	0.397 (0.052, 3.015), p=0.372	0.359 (0.045, 2.838), p=0.332
I don't experience electricity cut off	0.845 (0.248, 2.876), p=0.788	0.919 (0.260, 3.248), p=0.895
Checking the temperature of fridge/freezer		
I don't check it	1 (Reference)	1
Once/day	1.641 (0.820, 3.282), p=0.162	1.389 (0.685, 2.819), p=0.363
Twice/day	**5.189 (2.581, 10,431), p=0.000**	**3.987 (1.896, 8.386), p=0.000**
> 3 times/day	**3.193 (1.380, 7.383), p=0.007**	**2.895 (1.171, 7.159), p=0.021**

E. Participants Practices Associated with Food Safety:

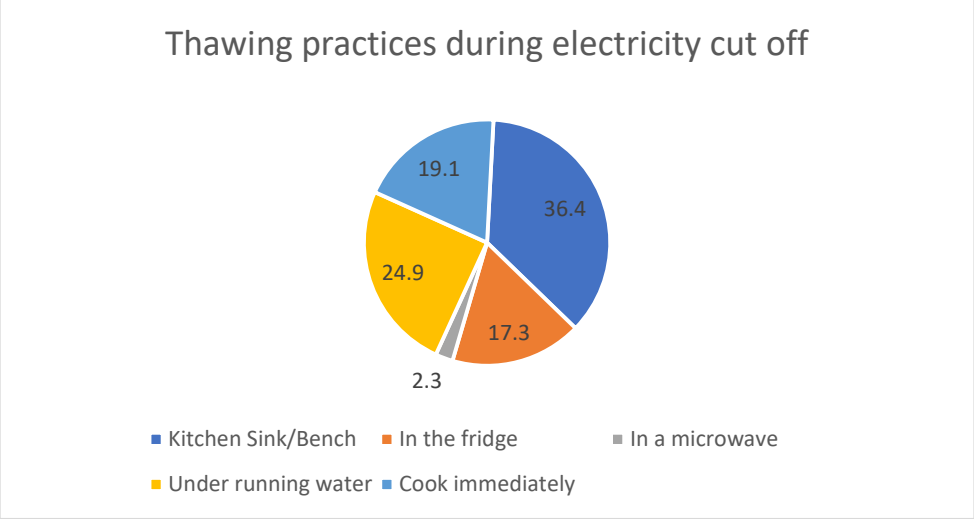
The mean food safety practice score was 10.79 ± 2.451 (< 14, which is the 70% of the total practice score ranging from 0 to 20) resulting unacceptable food safety practices among the participants during electricity outages. Almost 536 (93.9%) of the participants scored poor food safety practices and 35 (6.1%) scored good practices. After the economic crisis and during the electricity shortages, 82% of the participants reduced the purchasing of some food types (chicken, meat, fish, milk, and cheese) (Table 12). Around 27.7% had to eat food not refrigerated properly because they had no food, and 37.7% they ate the inadequately refrigerated food because they don't like to throw it. In addition, only 20.3% of the respondents take the temperature of refrigerated or frozen food during electricity outage (Table 12).

Table 12. Economic crisis along with electricity cut-off effect on purchasing/eating practices

Question statement	Response	Percentage (%)	Frequency (N)
After the economic crisis and electricity shortages, did you reduce your purchasing of certain food (meat, chicken, fish, cheese, milk)	Yes No	82 18	468 103
Have you ever eaten food that was not refrigerated properly because you had no other food?	Yes No	27.7 72.3	158 413
Have you ever eaten food that was not refrigerated properly because you don't like to throw food?	Yes No	37.7 62.3	215 356
During electricity cut-off, do you take the temperature of food inside fridge/freezer?	Yes No	20.3 79.7	116 455

Different methods of food thawing were presented to the participants in order to determine the one that they usually follow in their households during electricity cut-off. 36.4% of the samples thaw their frozen food on kitchen bench or in kitchen sink whereas 63.6% thaw the food whether inside the fridge, in a microwave, under running water or cook immediately (Figure 1).

Figure 1. Pie Chart of thawing practices during electricity cut-off



According to table 13 that presents some of the asked practice questions during extended hours (more than 4 hours), 55.2% of responses chose to keep leftover cooked meals instead of discarding the meals which is the correct action to do. In addition, 70.2% reported that they keep the refrigerated cut vegetables instead of discarding them. In contrast, 61.5% chose the right answer in discarding the refrigerated raw meat and chicken if electricity was off for more than 4 hours. Around 72.3% also decided to the refrigerated hard cheeses (cheddar, Swiss, parmesan) since it's the right option. Similar to the 62.7% who chose the right action by discarding thawed meat and chicken without ice crystals inside the freezer.

Table 13. Score distribution of food safety practices questions

Question Statement	Correct answer	Wrong answer
After preparing and cooking the food that you will eat 3-4 hours later. What do you usually do?	42.2% (241)	57.8 (330)
During extended electricity cut-off, do you discard or keep leftover cooked meals inside fridge?	44.8% (256)	55.2% (315)
During extended electricity cut-off, do you discard or keep raw chicken/meat inside fridge?	61.5% (351)	38.5% (220)
During extended electricity cut-off, do you discard or keep soft cheeses inside fridge?	45.9% (262)	54.1% (309)
During extended electricity cut-off, do you discard or keep hard cheeses inside fridge?	72.3% (413)	27.7% (158)
During extended electricity cut-off, do you discard or keep cut vegetables inside fridge?	29.8% (170)	70.2% (401)
During extended electricity cut-off, do you discard or keep uncut vegetables inside fridge?	94.6% (540)	5.4% (31)
During extended electricity cut-off, do you discard or keep thawed meat/chicken without ice crystals inside freezer?	62.7% (358)	37.3% (213)

Table 14 presents the association between socio-demographic characteristics and food safety practice. The data indicates a significant association between food safety practices score and some characteristics such as household income, food safety

knowledge rating, and whether subjects check the temperature of their fridges and freezers.

Table 14. The association between socio-demographic characteristics and food safety practices score among participants

Variables	**Good Knowledge n(%)**	**Poor Knowledge n(%)**	**Total (n=571)**	**Significance**
Age group				P = 0.367
18 – 29	22 (7.3%)	278 (92.7%)	300	X^2= 4.301
30 – 39	10 (6.4%)	146 (93.6%)	156	
40 – 49	3 (4.6%)	62 (95.4%)	65	
50 – 59	0 (0.00%)	38 (100%)	38	
60 and more	0 (00.0%)	12 (100%)	12	
Gender				P = 0.340
Female	24 (6.9%)	324 (93.1%)	348	X^2= 0.911
Male	11 (4.9%)	212 (95.1%)	223	
Marital Status				P = 0.528
Single	22 (6.7%)	306 (93.3%)	328	X^2= 3.180
Married	11 (5.0%)	211 (95%)	222	
Divorced	2 (15.4%)	11 (84.6%)	13	
Widowed	0 (0.00%)	6 (100%)	6	
Separated	0 (0.00%)	2 (100%)	2	
Governorate of Lebanon				P = 0.180 X^2= 6.272
Beirut	14 (8.5%)	151 (91.5%)	165	
South	1 (1.8%)	55 (98.2%)	56	
North	5 (10.4%)	43 (89.6%)	48	
Mount Lebanon	13 (4.7%)	266 (95.3%)	279	
Bekaa	2 (8.7%)	21 (91.3%)	23	
Nationality				P = 0.940
Lebanese	32 (6.1%)	492 (93.9%)	524	X^2= 0.006
Non Lebanese	3 (6.4%)	44 (93.6%)	47	
Educational Level				P = 0.544
School (Primary, Middle, High)	12 (8.6%)	128 (91.4%)	140	X^2= 2.137
Bachelor degree	14 (5.2%)	256 (94.8%)	270	
Master/PhD	7 (5.2%)	127 (94.8%)	134	
Technical school	2 (7.4%)	25 (92.6%)	27	
Household Income				**P = 0.034**
< 1,000,000 L.L	2 (15.4%)	11 (84.6%)	13	**X^2= 8.672**
1,000,000 – 5,000,000 L.L	11 (8.4%)	120 (91.6%)	131	
5,000,000 – 10,000,000 L.L	15 (8.1%)	171 (91.9%)	186	

>10,000,000 L.L	7 (2.9%)	234 (97.1%)	241	
Are you the **primary food handler** in your household?				P = 0.742 X^2= 0.108
Yes	17 (6.5%)	245 (93.5%)	262	
No	18 (5.8%)	291 (94.2%)	309	
How do you rate your **food safety knowledge**?				**P = 0.000** **X^2= 20.205**
Excellent	15 (15.8%)	80 (84.2%)	95	
Good	19 (4.9%)	370 (95.1%)	389	
Weak	1 (1.1%)	86 (98.9%)	87	
Checking the temperature of fridge/freezer				**P = 0.000** **X^2= 27.825**
I don't check it	10 (2.9%)	329 (97.1%)	339	
Once/day	8 (6.3%)	118 (93.7%)	126	
Twice/day	12 (20%)	48 (80%)	60	
> 3 times/day	5 (10.9%)	41 (89.1%)	46	

Total household income, self-rating food safety knowledge, and checking the temperature of fridges/freezers were found to have a significant associations with practices score level (Table 15). Households with income of more than 10,000,000 L.L per month, were 0.164 less likely to have a positive practice score comparing to those with less than 1,000,000 L.L of total income. Groups of people whom reported to have good (OR = 0.432) knowledge score, had lower odds in achieving a positive practice level when compared to those with excellent self-reported food safety knowledge. Moreover, higher odds were observed among participants whom check the temperature of their fridges and freezers twice per day (OR = 5.034), comparing to those who never check it throughout the day.

Table 15. Logistic regression analysis for the association between socio-demographic characteristics and other explanatory factor with the likelihood of having positive practice score

Variables	**Simple logistic regression OR 95% CI**	**Multiple logistic regression OR 95% CI**
Age group		
18 – 29	1 (Reference)	
30 – 39	0.866, (0.399, 1.877) p=0.714	
40 – 49	0.611, (0.177, 2.107) p=0.436	
50 – 59	0.000, (0.000) p=0.998	
60 and more	0.000, (0.000) p=0.999	
Gender		
Female	1 (Reference)	
Male	0.700 (0.336, 1.460), p=0.342	
Marital Status		
Single	1 (Reference)	
Married	0.725 (0.344, 1.527), p=0.398	
Divorced	2.529 (0.527, 12.126), p=0.246	
Widowed	0.000 (0.000), p=0.999	
Separated	0.000 (0.000), p=0.999	
Governorate of Lebanon		
Beirut	1 (Reference)	
South	0.196 (0.025, 1.527), p=0.120	
North	1.254 (0.428, 3.678), p=0.680	
Mount Lebanon	0.527 (0.241, 1.151), p=0.108	
Bekaa	1.027 (0.218, 4.841), p=0.973	
Nationality		
Lebanese	1 (Reference)	
Non Lebanese	1.048 (0.309, 3.561), p=0.940	
Educational Level		
School (Primary, Middle, High)	1 (Reference)	
Bachelor degree	0.583 (0.262, 1.298), p=0.187	
Master/PhD	0.588 (0.224, 1.542), p=0.280	
Technical School	0.853 (0.180, 4.049), p=0.842	
Household Income		
< 1,000,000 L.L	1 (Reference)	1
1,000,000-5,000,000 L.L	0.504 (0.099, 2.569), p=0.410	0.311 (0.056, 1.741), p=0.184
5,000,000-10,000,000 L.L	0.482 (0.098, 2.381), p=0.371	0.377 (0.071, 2.007), p=0.253
> 10,000,000 L.L	**0.165 (0.031, 0.886), p=0.036**	**0.164 (0.028, 0.948), p=0.043**
Are you the **primary food handler** in your household?		
Yes	1 (Reference)	

No	0.891 (0.450, 1.767), p=0.742	
How do you rate your **food safety knowledge**?		
Excellent	1 (Reference)	1
Good	**0.274 (0.133, 0.562), p=0.000**	**0.432 (0.200, 0.934), p=0.033**
Weak	**0.062 (0.008, 0.480), p=0.008**	0.132 (0.016, 1.094), p=0.061
Checking the temperature of fridge/freezer		
I don't check it	1 (Reference)	1
Once/day	2.231 (0.860, 5.786), p=0.099	1.567 (0.585, 4.199), p=0.372
Twice/day	**8.225 (3.370, 20.073), p=0.000**	**5.034 (1.916, 13.225), p=0.001**
> 3 times/day	**4.012 (1.307, 12.316), p=0.015**	2.250 (0.691, 7.321), p=0.178

As presented in tables 16, 17, and 18, there is a significant relationship between subject's knowledge and their beliefs and practices. There is also a significant associations between respondent's beliefs and their practices.

Table 16. The association between participant's practices and knowledge

Variables	**Poor Practices n(%)**	**Good Practices n(%)**	**Total (n=571)**	**Significance**
Knowledge:				**P = 0.001**
Bad	292 (97%)	9 (3%)	301	**X^2= 10.905**
Good	244 (90.4%)	26 (9.6%)	270	

Table 17. The association between participant's beliefs and knowledge

Variables	**Poor Beliefs n(%)**	**Good Beliefs n(%)**	**Total (n=571)**	**Significance**
Knowledge:				**P = 0.000**
Bad	288 (95.7%)	13 (4.3%)	301	**X^2= 30.360**
Good	219 (81.1%)	51 (18.9%)	270	

Table 18. The association between participant's beliefs and practices

Variables	**Poor Beliefs n(%)**	**Good Beliefs n(%)**	**Total (n=571)**	**Significance**
Practices:				**P = 0.005**
Bad	481 (89.7%)	55 (10.3%)	536	**X^2= 7.883**
Good	26 (74.3%)	9 (25.7%)	35	

CHAPTER IV

DISCUSSION

Throughout the years food safety reached a wider range of people than it ever did before. Despite all the knowledge people acquired in the field of food safety and the major attempts from all concerned stakeholders, there's still a major gap due to insufficiency of awareness among populations regarding the safety of the food. Especially that food can be contaminated at any stage of the food chain from receiving to consumption and can result in a serious risk of foodborne diseases (Havelaar, et al., 2010). In the present study, the knowledge, beliefs, and practices of consumers in households towards food safety during electricity outages were assessed.

The overall food safety knowledge was unsatisfactory (mean score was $10 \pm 4.112 < 11$). Similarly, a very poor food safety knowledge among food handlers was reported in households in China (Gong, et al., 2015). In the current study, results showed that 56.7% answered wrongly or didn't know the temperature of frozen food. Same question was asked in a study done in South Africa where 72% had no clue what is the proper temperature of freezers (Mkhungo, et al., 2018). Regarding the knowledge of refrigerators temperature, our results found that 51.3% of the participants didn't know the correct range of temperature. This finding is supported by Jevsnik, et al., (2007) where 56.3% of the consumers reported to know the proper temperature of the fridges. Moreover, 59.5% reported that freezing is not effective in killing bacteria and viruses. This rate was higher than a study conducted also in Lebanon in which only 35.8% knew that (Hassan, et al., 2018).

In a previous study by Faour-Klingbeil (2016), 77.5% of food handlers took the taste and the smell as a reference in determining if the food is contaminated or not. Whereas, in this study lower percentage was found, since 41.7% believed the same. However, this subject is very important to be risen among populations since safety of food can't be determined by the sensory properties, because some pathogens don't change the appearance nor the taste of contaminated food and still can cause food poisoning if consumed (Zeratsky., 2020).

More than half (65.1%) of the participants agreed that food poisoning can happen as result of consuming contaminated food only if it's consumed the same day or the day before. This can be an indicator also for a knowledge gap among the subjects since it was mentioned by the CDC (Centers for Disease Control and Prevention) that the onset of food poisoning symptoms can vary depending on the type of the pathogen and it can take hours, days, or even weeks to appear (CDC, 2021).

Regarding the beliefs towards food safety, the overall score was poor (mean score was $2.77 \pm 1.372 < 4$). 71.8% of people tend to purchase the high risk food (dairy, meat, chicken…) from big chain supermarkets instead of small local groceries since they believe that they are safer. However, there is no prove that chain supermarkets are not facing shortage of electricity throughout the day especially at night. Jevsnik, et al., (2007) stated that 67.8% of the respondents don't check the temperature in retail markets since it was the least important factor that the customers cared about. They explained this by whether the tendency of consumers to trust big chain supermarkets or they don't have control over the temperature setting.

According to the Centers for disease control and prevention (CDC, 2022), the safest way to cook the food is to reach the required the temperature in order to kill pathogens that cause illnesses. In this study, 65.3% depended on their experience (smell and taste the food) or visual appearance (color of food) to decide if food is cooked enough. A higher rate (78.31%) was observed in a study conducted in Saudi where they depend on sensory observations (Alsayeqh., 2014).

Moreover, 54.1% of the subjects believed that being vegan or vegetarian in Lebanon will reduce the chance of getting food poisoning since some vegetables don't need to be refrigerated as much as meat and chicken. In fact, according to the Australian Institute of Food Safety (2019), people who follow a vegan or vegetarian diets can also get foodborne illnesses. Some have the misconception of linking the poising only to meat, seafood, cheese.., but plant based food can easily be contaminated with toxins that can naturally occur, parasites, viruses, and bacteria, at any stage starting from the farm.

The total food safety practices during electricity outage was unacceptable and poor (mean score $10.79 \pm 2.451 < 14$). Methods of thawing were also assessed. Our findings were that 36.4% of the samples thaw their frozen food on kitchen bench or in kitchen sink. Similar results were reported in South Africa since 28% used their kitchen surfaces for thawing the food, and they also confirmed the contamination of kitchen surfaces with different pathogens such as *Listeria*, *Salmonella.spp.*, and *Escherishia.coli*. These findings highlight the danger behind using unsafe methods to thaw food. (Mkhungo, et al., 2018) However, Jevsnik, et al., (2007) reported higher rate (50.4%) of participants whom thaw frozen food on kitchen bench.

After preparing and cooking the food that will be eaten 3 – 4 hours later, we found that 57.8% of the participants store the food at room temperature and then reheat it to eat the food later. This finding of this study was higher when compared to other similar studies. Hassan, et al., (2018) reported that 45.5% keep their food on room temperature whether on the counter or inside the oven. In Slovenia, they found that only 12.5% leave their food at room temperature until they are eaten (Jevsnik, et al., 2007). This emphasize the differences between food safety practices between different populations and countries. According to Food and Drug Administration (FDA, 2018), food should not be left at room temperature more than 2 hours because bacteria can grow rapidly and can reach levels where food if consumed can cause illness.

During extended electricity outage, 62.7% discarded thawed frozen food that had no ice crystals. 61.5% discarded refrigerated meat/chicken and 45.9% discarded refrigerated soft cheeses after 4 hours of electricity cut-off. Whereas in USA when same questions were asked, only 37.1% threw totally thawed food inside the freezer and only 33% knew that they should throw refrigerated perishable food after 4 hours of power outage (Kosa, et al., 2011). Moreover, our results showed that only 20.3% of the participants take the temperature of the refrigerated food during electricity shortages. Kosa, et al., (2011) reported even lower rate (9%) did that.

According to Lebanon Food Security Portal (25) that was done by the American University of Beirut, inflation rates, dollarization, and the war in Ukraine caused a huge increase in the costs of food by more than 400% between February 2021 and February 2022. This issue is affecting both the availability and the accessibility of food. This might explain that 82% of the respondents of this study reduced their purchasing of

meat, chicken, dairy, and fish. 27.7% also they had to eat food that was not refrigerated properly since they had no other choice.

As demonstrated in the present study, it's important to mention that good food safety knowledge doesn't necessarily mean or reflect good food safety practices and vice versa. This was also observed in a similar study in Lebanon among married woman where they found that the knowledge of food safety may not indicate proper food safety practices (El Haddad, et al., 2020). Another article assessed food safety knowledge, attitudes and practices among food handlers in Malaysia and they concluded that despite scoring a good food safety knowledge, improper and unsafe practices were performed while handling the food (Lee, et al., 2017).

Limitations of the study should be declared. The study was conducted online, thus the sample is not representative since the distribution can't be controlled. Using the online social media for data collection can also cause selection bias. To illustrate, most of the respondents were from Mount Lebanon and very minimal responses were from North, south and Bekaa. Moreover, the highest participation percentage of age group was accounted for 18 – 29 years old whereas very minimal participation was observed of people aging 40 and more. It was also observed that more than half of the subjects were holding at least a bachelor degree at the university. All these variants can affect the representation of the study and its reflection degree of the citizens living in Lebanon. Online survey also didn't give the chance to the subjects who don't have internet access to participate. Lastly, data was also self-reported which can result in information bias or social desirability bias depending on how the participants understood the questions.

CHAPTER V

CONCLUSION AND RECOMMENDATIONS

To date, the present research is the first study in Lebanon and in the Middle East that presents data concerning food safety knowledge, beliefs, and practices during electricity cut-off highlighting many misconceptions towards food safety. This current study provides baseline to conduct further analysis in order to understand more the situation in Lebanon. The findings urge the governmental and nongovernmental authorities to take actions to enhance the food safety in Lebanon since the situations food safety and security is alarming. Moreover, national campaigns should be carried on to increase awareness and improve the knowledge among Lebanese populations towards food safety practices during electricity outage. More frequent inspections to be done to ensure that food safety regulations are not violated in retails shops to keep the food safe for consumption

APPENDIX I

INVITATION SCRIPT

Invitation to Participate in a Research Study

This notice is for an AUB-IRB Approved Research Study for Dr. Samer Kharroubi at AUB. (Phone: (01) 350 000 Ext: 4541)

(Email: sk157@aub.edu.lb)

It is not an Official Message from AUB

I am inviting you to participate in a research study about **"Beliefs, practices, and knowledge of food handlers in households regarding electricity outage effect on food safety: National cross-sectional study in Lebanon**

You will be asked to complete a short survey/questionnaire with demographic information

You are invited because we are targeting people who are at least 18 years old and are currently residing in Lebanon

The estimated time to complete this survey is approximately 5 to 10 minutes

The research is conducted online and is hosted on AUB server

Please read the consent form and consider whether you want to be involved in the study

If you have any questions about this study, you may contact the investigator/research team (Noura Subuh, 70920682, noa13@mail.aub.edu)

APPENDIX II

CONSENT FORM

Dear Participant,

You are invited to participate in a research study entitled "Beliefs, practices, and knowledge of food handlers in households regarding electricity outage effect on food safety: national cross-sectional study in Lebanon"
This study is conducted by Dr. Samer Kharroubi, Department of Nutrition and Food Sciences, American University of Beirut. The main objective of this study is to assess the beliefs, practices and knowledge related to electricity outage effect on food safety among food handlers in households in Lebanon and to raise awareness that could be beneficial for the reduction and prevention of foodborne diseases.
This message invites you to read the consent document and consider whether you want to be involved in the study.

And to note that:

- This is not an official message from AUB
- Participation is completely voluntary.
- This study will include a sample of participants who are at least 18 years old, and are currently residing in Lebanon.
- The recruitment of the participants will be through online surveys.
- Completing the questionnaire will take around 10 minutes.
- Only the data you provide in the questionnaire will be collected and analyzed.
- The survey is anonymous and there are no personal or identifying information.
- The research team does not have access to your name or contact details.
- Data collected will be monitored and may be audited by the IRB while assuring confidentiality.
- You may download the consent form if you wish to keep a copy.

POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY

You will not receive any payment for participation in this study. Also, there will be no direct benefits to you.

However, studying the beliefs, practices and knowledge of people residing in Lebanon will provide us with valuable insight on how well informed this population is and raise awareness in order to reduce foodborne diseases.

POTENTIAL RISKS TO SUBJECTS AND/OR SOCIETY

The risks of the study are minimal and your participation in this survey does not involve any distress.

CONFIDENTIALITY

The collected data will remain confidential and anonymous. It will be stored on the PI's password protected computer, and only the research team would have access to it. Data will be monitored and may be audited by the IRB while assuring confidentiality.

We will be using the information collected from the surveys for our master's thesis project, which is a requirement for our degree at the Department of Nutrition and Food Sciences. Findings from this study will be used for research purposes only.

PARTICIPATION AND WITHDRAWAL

If you voluntarily consent to take part in this study, you can change your mind and withdraw at any time without consequences of any kind. Refusal to participate in the study will involve no penalty or loss of benefits to which you are otherwise entitled. Also, your refusal to take part in the study will not affect your relationship with AUB.

QUESTIONS ABOUT THE STUDY

If you have any questions or concerns about the study, you can contact Dr. Samer Kharroubi at sk157@aub.edu.lb

CONCERNS OR QUESTIONS ABOUT YOUR RIGHTS

If you have concerns about the study or questions about your rights as a participant, you can contact the American University of Beirut (AUB) Social and Behavioral Institutional Review Board (IRB) at irb@aub.edu.lb or AUB extension: 5445.

ACCESS TO THE SURVEY

If after reading the consent document and having your questions answered, you voluntarily agree to take part in the study, you can access the survey by answering the questions below.

APPENDIX III

QUESTIONNAIRE

Section 1: Socio - demographic characteristics

1. Please select your age group:
    a) (18 – 29)
    b) (30 – 39)
    c) (40 – 49)
    d) (50 – 59)
    e) (60 and above)

2. What is your gender?
    a) Male
    b) Female
    c) Other

3. What is your marital status?
    a) Single
    b) Married
    c) Divorced
    d) Widowed
    e) Separated

4. In which governorate of Lebanon do you live?
    a) Beirut
    b) South
    c) North
    d) Mount Lebanon
    e) Bekaa

5. What is your nationality?
    a) Lebanese
    b) Non-Lebanese. Please specify _____

6. What is your highest educational level achieved?
    a) Primary school
    b) Middle school
    c) High school

d) University degree (Bachelor)
e) University degree (Masters/PhD)
f) Technical school

7. If you choose a university degree, please specify the major _____

8. What is the total monthly income of your household?
   a) Less than 1,000,000 L.L
   b) 1,000,000 – 5,000,000 L.L
   c) 5,000,000 – 10,000,000 L.L
   d) More than 10,000,000 L.L

Section 2: Basic questions related to food safety in households

1. Are you the primary food handler in your household?
   a) Yes
   b) No

2. Are you involved in food preparation at your house?
   a) Yes
   b) No

3. How many hours per day do you experience electricity cut off at your house?
   a) I don't experience electricity cut off
   b) Less than 2 hours
   c) 2 – 4 hours
   d) More than 4 hours

4. If you experience an electricity cutoff, can you specify the schedule of electricity cutoff at your house?
   a) Not more than 2 hours continuous
   b) Between 2 – 4 hours continuous
   c) More than 4 hours continuous

5. With electricity cuts, are you spending more effort on cooking food (using oven, grill, stove) that you usually consume directly from the fridge (e.g. Deli meat, cheese...)?
   a) Yes
   b) No

6. Did the electricity cuts change your perishable food (foods that need refrigerator: meat, chicken, dairy) storage habits?
   a) Yes
   b) No

7. With the electricity cuts, did you cut down on purchasing perishable foods due to the inability to refrigerate properly?
    a) Yes
    b) No

8. Do you know that deficient refrigeration may affect the safety and quality of food?
    a) Yes
    b) No

9. Do you know that foodborne pathogens can survive refrigeration?
    a) Yes
    b) No

10. Do you know that foodborne pathogens can multiply on food that was not refrigerated properly?
    a) Yes
    b) No

11. Did you experience diarrhea, vomiting, fever, or abdominal pain in the past 6 months?
    a) Yes
    b) No

12. Have you been hospitalized because of food poisoning in the past 6 months?
    a) Yes
    b) No

13. If yes, did the doctors confirm that it's food poisoning?
    a) Yes
    b) No

14. Do you know anyone (other than yourself) who got food poisoning in the past 6 months?
    a) Yes
    b) No

15. Do you know anyone (other than yourself) who experienced diarrhea, vomiting, fever, or abdominal pain in the past 6 months?
    a) Yes
    b) No

16. Have you ever eaten food that was not refrigerated properly because you had no other food?
    a) Yes
    b) No

17. Have you ever eaten food that was not refrigerated properly because you don't like to throw food?
    a) Yes
    b) No

18. Do you know what Escherichia coli is?
    a) Yes
    b) No

19. Do you know what Campylobacter is?
    a) Yes
    b) No

20. Do you know what Listeria is?
    a) Yes
    b) No

21. Do you know what Salmonella is?
    a) Yes
    b) No

22. Do you know what Staphylococcus aureus is?
    a) Yes
    b) No

23. Do you know that food can be contaminated by bacteria that can make you sick?
    a) Yes
    b) No

24. Do you know that food can be contaminated by viruses that can make you sick?
    a) Yes
    b) No

25. Do you know that food can be contaminated by parasites that can make you sick?
    a) Yes
    b) No

26. Choose the best way to reduce the risk of contaminated food among the listed?
    a) Cooking
    b) Refrigeration
    c) Washing the food
    d) I don’t know

27. How do you rate your food safety knowledge?
    a) Excellent
    b) Good
    c) Weak

Section 3: Knowledge about food safety

1. Food poisoning can happen as a result of consuming contaminated food on the same day or the day before only.
    a) True
    b) False
    c) I don’t know

2. If the smell and the color of the food seem okay, that means that the food is not contaminated.
    a) True
    b) False
    c) I don’t know

3. Storing raw chicken in the fridge without proper precaution can contaminate other food in the fridge.
    a) False
    b) True
    c) I don’t know

4. Drippings from raw chicken and meat can contaminate food in the fridge and kitchen.
    a) True
    b) False
    c) I don’t know

5. How do you thaw frozen foods?
    a) On the kitchen bench
    b) In the kitchen sink
    c) In the fridge
    d) In a microwave

e) Under running water
f) Cook immediately

6. How do you thaw frozen foods during extended electricity shortages?
    a) On the kitchen bench
    b) In the kitchen sink
    c) In the fridge
    d) In a microwave
    e) Under running water
    f) Cook immediately

7. What is the optimal temperature of frozen food?
    a) 0°c
    b) - 5°c
    c) - 18°c
    d) I don’t know

8. What is the optimal temperature of fridge?
    a) 1 - 4°c
    b) 5 - 9°c
    c) 10 - 12°c
    d) I don’t know

9. Is freezing enough to eliminate foodborne bacteria and viruses?
    a) Yes
    b) No

10. Is refrigeration enough to eliminate foodborne bacteria and viruses?
    a) Yes
    b) No

11. In the electricity crisis, for purchasing high-risk food (dairy, meat, chicken, fish..), do you use big chain supermarkets instead of small local grocery stores since they are safer?
    a) Yes
    b) No

12. After preparing and cooking the food that you will eat 3 – 4 hours later. What do you usually do?
    a) Store the food at room temperature then reheat it
    b) Store the food inside microwave/oven then reheat it
    c) Store the food inside the fridge then reheat it

13. How do you know if food is cooked enough?
    a) By experience (smelling and tasting the food)
    b) By cooking according to the recommended time to reach the required temperature
    c) By visual appearance (color of the food)
    d) I don't know

14. During a long electricity cutoff, for how long do you think the fridge will keep the food safely cool (if doors are kept closed)?
    a) 4 hours
    b) 5 - 12 hours
    c) More than 12 hours
    d) I don't know

15. During a long electricity cutoff, for how long do you think a full packed freezer will keep the food safely frozen?
    a) 24 hours
    b) 48 hours
    c) 72 hours
    d) I don't know

16. During a long electricity cutoff, for how long do you think a half packed freezer will keep the food safely frozen?
    a) 24 hours
    b) 48 hours
    c) 72 hours
    d) I don't know

Section 4: Beliefs towards the risks associated with food safety

1. During the electricity crisis, did you limit your visits to restaurants for fear of getting food poisoning?
    a) Yes
    b) No

2. During the electricity crisis, did you strictly eat at home because you know that the food has been safely stored (frozen/cold)?
    a) Yes
    b) No

3. Do you believe that being vegan or vegetarian now in Lebanon will reduce the chance of food poisoning? Since some vegetables don't need to be refrigerated as much as meat and chicken.
    a) Yes
    b) No

4. How do you usually eat your meat?
    a) Well done
    b) Medium – rare
    c) Rare
    d) I don't eat meat

5. With the electricity cutoff and with the increase of food poisoning cases in Lebanon, did you shift from ordering medium- rare meat to order well done meat?
    a) Yes
    b) No

6. What food are you afraid the most to eat from outside your house (restaurants) during electricity cut-off?
    a) Burger/sandwiches
    b) Sushi
    c) Salads
    d) Everything
    e) Nothing

Section 5: Practices that could increase the risk of food poisoning

1. How often do you check the temperature of your fridge/freezer?
    a) Once/day
    b) Twice/day
    c) More than 3 times/day
    d) I don't check it

2. During electricity cut-off, do you take the temperature of food inside the fridge/freezer?
    a) Yes
    b) No

3. If electricity was off for more than 4 hours consecutive, what do you usually do with the refrigerated food?
    a) I take the temperature of the food and then decide to keep or not
    b) I smell and taste the food and then decide to keep or not

c) I keep the fridge closed until the electricity is back again
d) I discard all the food directly
e) I don't do anything

4. After the economic crisis and electricity shortages, did you reduce your purchasing of certain food (chicken, meat, cheese, milk, fish)
    a) Yes
    b) No

5. If electricity was off for more than 4 hours consecutive, what do you usually do with the frozen food?
    a) Discard the food as a waste
    b) Consume/cook the food directly
    c) Transfer the food from fridge to freezer
    d) I take the temperature of the food and then decide to keep or not
    e) Keep the food inside the freezer and do nothing

6. When electricity is off for more than 4 hours. What is the best action to do regarding the following food items:

Food item	Fridge/Freezer	Discard	Keep
Leftover cooked meals	Fridge		
Raw meat/chicken	Fridge		
Pizza (any topping)	Fridge		
Soft cheeses (Halloumi, kashkavan, mozzarella)	Fridge		
Hard cheeses (cheddar, Swiss, parmesan)	Fridge		
Milk	Fridge		
Peanut butter	Fridge		
Opened mayonnaise-based dressing	Fridge		
Cooked rice, pasta, potato	Fridge		
Fresh vegetables (cut)	Fridge		
Fresh vegetables (uncut)	Fridge		
Bread	Fridge		
Egg products/custard	Fridge		
Thawed meat/ chicken with ice crystals	Freezer		
Thawed meat/ chicken without ice crystals	Freezer		
Thawed Ice cream	Freezer		

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