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An on-line survey of the behavioral changes in Lebanon, Jordan and Tunisia during the COVID-19 pandemic related to food shopping, food handling, and hygienic practices

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ABSTRACT

The impact of the novel coronavirus pandemic (COVID-19) has spanned across the various aspects of life globally. Understanding public reactions is vital for effective risk communication and outbreak control and prevention. The Arab world has diverse cultural, economic, and social structures, so public choices and decisions also vary. To investigate the changes in behavior related to food shopping and handling, precautions measures, and hygiene practices of the public during the pandemic, a web-based survey tool was developed and conducted on 1074 subjects in three Arab countries, Lebanon, Jordan, and Tunisia, using a snowball sampling technique. The results showed a significant reduction in RTE consumption during the pandemic, as shown in the 19.2% and 12.2% rise in the proportion of respondents not ordering hot and cold RTE food delivery, respectively. Compared to pre-COVID-19 times, a substantial increase in behaviors related to hygiene and disinfection practices (22.0%–32.2%) was observed with a lesser increase (11.2%) in handwashing practices before food preparation. Moreover, public concerns about contracting COVID-19 from food led to almost doubling the number of Tunisians using cleaning agents for washing fresh fruits and vegetables (e.g., soaps, non-food grade chlorine bleach) besides a 16% and 26.1% increase in use among the Jordanian and Lebanese, respectively. However, a third of the respondents did not follow instructions on labels for the use of chemical products. In conclusion, this study identified culture-specific shortfalls in handwashing and unsafe food handling practices during COVID-19 in the Arab countries and sheds light on the paramount role of coordinated efforts between the local health authorities and the food safety and public health stakeholders in risk communication. To reduce health risks, there need to be rigorous educational campaigns and targeted messages that reach out to the general audience on hand hygiene, the health effects of haphazard use of unsafe chemical compounds on food, and recommendations on following label instructions.

1. Introduction

The year 2020 marked a new era of public health significance as the world has witnessed the rapid global spread of a new respiratory disease, caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), more commonly known as COVID-19 or the COVID-19 pandemic. The unpreparedness of nations to respond to such a respiratory virus was readily apparent as it spread rapidly around the world from China through person-to-person transmission (Mellish et al., 2020; Thurbon & Weiss, 2020). Governments had not put resources for public health agencies to respond to pandemics. This was despite previous epidemics of avian influenza (bird flu) and the Middle East Respiratory

Syndrome (MERS) and West Nile Fever in recent decades (Jefferson, 2020). Where governments did not take clear instructions to its agencies and the public, the news media and social media gave conflicting advice including the use of face masks in public places and whether herd immunity would bring the disease under control (Grewal, 2020; Hauer & Sood, 2020). This was seen in the early phase of the pandemic when there was little understanding of how great a risk Covid-19 posed to the population that governments avoided unjustified scares and fears about the health risks. Consequently, the coronavirus COVID-19 affected 213 countries and territories around the world and several European countries, as well as the United States, were in shortage of adequate resources such as ventilators, diagnostic tests, and personal protective equipment

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for health workers. As of January 3, 2021, 85,405,500 are infected and 1,849,196 died because of COVID-19 (Worldometer, 2020). Understandably, public anxieties and worries are elevated in many parts of the world as the number of people infected by the virus has kept increasing worldwide (Fardin, 2020).

Fears and worries are amplified by misperception, and often they do not match the facts to the extent that the public tends to exaggerate their reactions to risks (Ropeik, 2004). Various factors contribute to public risk misperception, such as people uncertainty, the dreadful events caused by the hazard, trust in information and institutions involved to protect the public, and the novelty of the risk (Liu et al., 2014; Lobb et al., 2007; Ropeik, 2004; Rutsaert et al., 2013; Slovic, 2016); these factors are generally part of COVID-19 characteristics being for its novelty, dreadfulness, the associated uncertainties, and its lethality.

Exaggerated fears impose changes with multidimensional impacts. Socially, the discrimination and social stigma against those with different backgrounds or opinions associated with COVID-19 were rising (CDC, 2020a; UNICEF, 2020). At the same time, COVID-19 has induced increased use of personal hygiene products and changes in consumption patterns towards more local buys (Accenture, 2020). The COVID-19 pandemic and lockdown resulted in changes to global food systems and consumer eating habits, both what is being eaten and where meals are being consumed (McKinsey & Company, 2020). More purchases are being made at convenience stores and local outlets such as independent butchers, alongside an increase in online shopping. As the food system shifts towards a 'new normal', it is key for policymakers to understand the changes in consumer perceptions, preferences, and trust of foods (Armstrong & Reynolds, 2020). Public priorities have become more focused on satisfying basic needs, and consumers adopted new practices and behavior to outmanoeuvre uncertainties such as adopting digital and low-touch activities, including video conferences, e-learning, and ordering grocery delivery (Accenture, 2020). Such a global shift in consumers' behaviors contributed to the repercussions on the economy particularly of the small fragile businesses resulting from closures and mass layoffs due to the lockdown, staff health concerns, and the reduced demands (Bartik et al., 2020).

The McKinsey report shed light on two Arab countries, Qatar and the United Arab Emirates (UAE), showing that the prevailing sentiment among consumers was the uncertainty about the health of family members and the duration of the COVID-19 crisis (McKinsey & Company, 2020). Although consumers in Qatar are optimistic about the country's economic recovery after the COVID-19 situation subsides, they are cutting their spending on almost all categories except groceries and home supplies. In both countries, Qatar and UAE, there is an increased behavior regarding food delivery and grocery delivery. It is speculated that many of these new ways of adapting to the crisis are to last and remain unchanged post-pandemic (McKinsey & Company, 2020).

Moreover, people were tempted to adopt health-threatening practices for protection against COVID-19. Numerous products containing chlorine dioxide or its derivatives have been marketed alone or in combination with other products, with false claims that they can kill COVID-19 and other associated ailments (PAHO/WHO, 2020). Despite conclusive statements on the unlikelihood of contracting COVID-19 via food or any imported products (CDC, 2020b; ECDC, 2020; FAO, 2020; The German Federal Institute for Risk Assessment, 2020) public concerns about food safety were mounting producing a new wave of health-threatening practices. For instance, recent findings of the Centers for Disease Control and Prevention (CDC) survey showed that a third of surveyed subjects in the United States were engaged in high-risk practices such as applying household cleaning or disinfectant products to bare skin and intentionally inhaled or ingested the cleaners, but also used disinfectants in risky ways such as washing food with bleach (Gharpure, 2020).

According to Jayaseelan et al. (2020), there is no doubt that social media channelled lots of misinformation and rumors on COVID-19

which amplified panic. The proliferating misinformation and consequential panic emphasized the critical role of a transparent, clear, and exact communication with the public on the nature of the risks (RTI, 2020). The Internet users, including Facebook in Arab states, comprised 51.6 percent of the population in 2019 (ITU, 2019), of that 53.5%, 58%, and 62.3% of the population in Jordan, Lebanon, and Tunisia being Facebook subscribers, respectively. Public reactions in the Arab countries regarding food consumption and food handling are also likely to be shaped by the kind of information they receive on social media and might, in turn, have health and economic implications.

Social media was a key source of information to the surveyed subjects in Lebanon, Jordan, and Tunisia (Faour-Klingbeil et al., 2021). Seventy percent of them were concerned that COVID-19 may be transmitted through food (Faour-Klingbeil et al., 2021). Data describing the food shopping behavior and hygiene practices to prevent transmission of SARS-CoV-2 within household settings in the Arab region are limited. Since March 2020, several MENA countries have gradually relaxed their complete (or partial) lockdown strategies. Understanding and anticipating public reactions are instrumental in prevention strategies and for effective communication of risk.

To understand the changes in food shopping and handling, food choices, and hygiene practices during the pandemic, a web-based survey was constructed and conducted in three Arab countries, Lebanon, Jordan, and Tunisia. This survey aimed to provide insight into the public responses during COVID-19 across the three countries and generate baseline information to help decision-makers improve risk communication and devise appropriate prevention strategies.

These three countries were chosen because each is considered a middle-income country with limited resources but has a relatively well-developed public health system, mature education systems, good human resources in science and technology, and the native-born population compared to wealthier or emerging countries in the region.

2. Materials and methods

2.1. Survey instrument

A structured web-based survey tool was developed in which respondents were asked to answer questions related to their knowledge on Sars-CoV-2 survival in food, to report their level of concerns of getting COVID-19 disease from food and during food shopping, their practices during food handling, the source of information they rely on to protect themselves and their trust and opinion on local authorities performance with regards to risk communication during the COVID-19 pandemic.

The questionnaire consisted of 23 questions and comprised 3 sections:

(i) Section 1: Demographic information

The demographic section contained five questions related to age, gender, education, employment sector, and country of residence.

(ii) Section 2: risk perception and behavioral changes

This section comprises fourteen questions built around three themes:

- (1) Food shopping and ready-to-eat food purchases,
- (2) Hygiene practices
- (3) Risk perception and knowledge

Only the first and second themes were included in this paper.

Theme (1) was designed to explore behavioral changes related to the consumption of ready-to-eat foods (RTE) foods by asking respondents to report on a 6-point Likert scale (1 = More than twice a week, 5 = Never, 6 = No access to food delivery) the frequency of ordering RTE before and during the pandemic. In this question, the level 6 option was added to

the scale as in some Arab countries, food delivery may not be available, hence, it is statistically inaccurate to count those cases as “never.”

Theme (2): On a five-point Likert scale (1 = Never, 5 = Always), respondents were asked to report the frequency with which they use the cleaning agents to wash the fresh fruits and vegetables (FFV) before and during the pandemic. The cleaning agents would be in that case formerly selected from a multiple-choice question, and respondents can select more than one choice that applies. Similarly, using the same frequency scale, six statements on the protective measures and hygienic practices before and during the pandemic were designed to investigate respondents' behavioral changes as a result of COVID-19 risks and to identify if there is a disparity compared to their concerns towards food safety.

This section also contained questions about respondents' willingness to change their current food shopping behavior after the pandemic and whether they follow the instructions on the cleaning agents' label used to wash FFV.

The questionnaire was initially designed in English. To ensure the quality of the translation, native speakers performed a back-translation. The survey and the procedure to be followed were approved by the Ethical Approval Committee of the Institutional Review Board of the University of Plymouth and Jordan University of Science and Technology in Jordan, and the Regional Research Center of Oasis Agriculture of Degache, Tozeur in Tunisia.

2.2. Survey procedure

2.2.1. Pre-test stage

Before the actual data collection, the survey was piloted by 36 respondents from Lebanon, Jordan, and UAE to assess readability, examine content reliability, and ensure it provided the desired information. The length of the survey was evaluated as well.

The participants were contacted via social media applications (Facebook Messenger and WhatsApp) and by Email to invite them to participate in the pilot study. They were asked to send back any feedback or comments on the survey by Email or via a WhatsApp.

All suggested changes were considered besides small adaptations for terminology. The survey was also reviewed for content validity and clarity by two food safety experts. One expert based in Iraq and a native Arabic speaker with a substantial academic and professional background in food safety. The second is a US-based expert with a long track record in survey research in food safety. The questionnaire was revised based on their recommendations.

2.2.2. Survey administration and participants recruitment

We used a convenience sample of general consumers with various backgrounds in Lebanon, Jordan, and Tunisia. We aimed to collect data from 380 to 400 people in each country to achieve ten respondents per variable as the lower limit to ensure an acceptable margin of error within each country (Hair et al., 2010; Kotrlík and Higgins, 2001, pp. 46–49).

The survey was conducted as an anonymous online survey through Google Forms, a survey administration app that is included in the Google Drive office suite. It is a cloud-based data management tool used to design and develop web-based questionnaires and provides various options for capturing the data from the multiple answers.

The invitation for participating in the web survey was sent via Facebook, LinkedIn, and WhatsApp. In the interest of reaching out to broader participants, the web link was also shared via Email to contacts living/residing in Lebanon, Jordan, and Tunisia. The invitation was posted again as a reminder on several Facebook groups. We did not post in public groups categorized by gender or specific profession to avoid biased sampling.

Sampling relied mainly on the snowball technique, i.e., referrals from initial subjects to generate additional subjects. Hence, participants were also encouraged to invite family, friends, and colleagues to

participate by forwarding the online survey link. Some of the participants shared the web link on their Facebook page.

The survey instrument was distributed in English and Arabic and was open for participation from April 28 to June 2, 2020. On the first page of the web survey, participants were provided with the study details, including their right to discontinue participating at any time. Screening questions were used to ensure that participants were over 18 years and live in one of the three countries. To continue with the survey, informed consent was obtained from participants through a check to the box “Agree” required to confirm reading the consent information for participation and that they are above 18 years and living (residing) in Lebanon, Jordan, or Tunisia”.

Google Forms does not need to key-in respondent data manually; hence the data coding error is minimized, and data were exported to SPSS 26 for statistical analysis.

2.3. Statistical analysis

All data were analyzed using the Windows version of SPSS 26, Statistical Package for Social Sciences. Descriptive statistical analysis (frequencies, percentages) were performed to summarize the socio-demographic characteristics of respondents and the distribution.

Cross tabulations and chi-square with Fisher's exact tests were used for proportions tests. We also use the Kruskal-Wallis test to compare the independent ordinal variables related to behavioral changes among the different countries.

One-Way ANOVA test was used to compare the mean scores on selected test parameters between countries (i.e., frequency level of hygiene practices and precautionary measures). Parametric tests such as Analysis of Variance can be used to summarize the Likert scale rating using means and standard deviations (Norman, 2010).

Wilcoxon signed-rank test was conducted to investigate if there was a change in respondents' behavior before and during the pandemic. Results with a p-value < 0.05 were considered statistically significant.

A reliability analysis test was performed using Cronbach's alpha to measure the internal consistency of the survey questionnaire. Cronbach's Alpha values ranged from 0.797 to 0.927 for the six categorical questions, which indicate a high level of internal consistency for our scale.

3. Results and discussion

A total number of 1074 subjects participated in this survey. The demographic characteristics of the respondents for each country are shown in Table 1. As part of the ethical approval requirements, the survey form was set to allow respondents to continue the survey even when they choose not to answer any of the questions. This explains the few missing answers to some of the questions.

3.1. Food shopping and food delivery

3.1.1. Frequency of food shopping

More than a third (33%) and 31% of the respondents stated that they shopped for food once a week and two to three times a week during the COVID-19 pandemic, respectively. In comparison, 25% purchased food less than once a week. Obtaining food and groceries by supermarkets or food shops' delivery services was not common in the three countries (10%) and was significantly the least reported among the Tunisians (Table 2). Besides, there were no substantial differences in the proportion of those who shopped for food once a week or more frequently (two to three times a week) during the pandemic. Family needs, household food mismanagement, or commonly ingrained habits of buying fresh raw foods are likely the reasons; also, the trust that consumers may have in the food shops may confer some degrees of reassurance not to change or reduce their shopping habits. For instance, Jribi et al. (2020) found that 67% of the consumers in Tunisia trusted shopping in the

Table 1
Sample characteristics.

		Country						
		Lebanon		Jordan		Tunisia		
		N	%	N	%	N	%	
TOTAL SAMPLE SIZE (N = 1074)		346	32.2	410	38.2	318	29.6	
Gender	Female	236	68.2%	307	75.3%	188	59.5%	
	Male	109	31.5%	98	24.0%	126	39.9%	
	I prefer not to say	1	0.3%	3	0.7%	2	0.6%	
	Total	346		408		316		
Age	19–24	21	6.1%	144	35.1%	34	10.7%	
	25–34	91	26.4%	75	18.3%	102	32.1%	
	35–44	101	29.3%	90	22.0%	121	38.0%	
	45–54	97	28.1%	69	16.8%	39	12.3%	
	55–64	21	6.1%	22	5.4%	20	6.3%	
	65+	14	4.1%	10	2.4%	2	0.6%	
	Total	345		410		318		
Education	Less than a high school degree	0	0.0%	8	2.0%	2	0.6%	
	Specialist/professional training	4	1.2%	7	1.7%	11	3.5%	
	High school degree/Diploma	23	6.6%	44	10.9%	35	11.3%	
	Bachelor degree (BSc., B.A.)	114	33.0%	272	67.3%	94	30.2%	
	Master degree	163	47.1%	56	13.9%	107	34.4%	
	Doctorate	42	12.1%	17	4.2%	62	20.0%	
	Other	0	0.0%	0	0.0%	0	0.0%	
	Total	346		404		311		
	Field of work	Food and Agriculture	93	28.2%	46	12.0%	106	35.3%
		Trade and business	65	19.7%	42	11.0%	32	10.7%
Biological, medical, healthcare		31	9.4%	90	23.5%	26	8.7%	
Other related natural science fields		20	6.1%	5	1.3%	20	6.6%	
Education		49	14.8%	100	26.1%	38	12.7%	
Unemployed		28	8.5%	67	17.5%	49	16.3%	
Other		44	13.3%	33	8.6%	29	9.7%	
Total	330		383		300			

supermarkets because of the adequate implementation of the stores' safety measures such as social distancing and continuous cleaning and hygiene. Like our study, the authors observed that more than a third (39.8%) of the Tunisian consumers performed food shopping once a week, 31.0% two or three times a week, 15.0% daily, and 7.5% every 2 weeks, and 3.5% once a month. Also, only a small percentage of Tunisian consumers (2.1%) relied on food delivery or bought their foods online (Jribi et al., 2020).

Furthermore, our results showed that more than a third (34%) of the respondents reported they would continue food shopping after the pandemic with the same frequency reported during the outbreak. On the other hand, 65% percent of the surveyed subjects will not or were unsure, of those, almost half (47%) were willing to visit food and grocery shops more often when the pandemic is over. From these results, it seems that the moderate and extreme concerns of the surveyed subjects from the risks of being exposed to the coronavirus through eating and buying food, and from touching food packages and exposure to infected people during shopping (Faour-Klingbeil et al., 2021) have negatively impacted their normal food shopping behavior.

Table 2
The frequency of food shopping during the pandemic.

		Lebanon		Jordan	Tunisia	Total
		N (%)	N (%)	N (%)	N (%)	N (%)
How often do you go shopping for food during the pandemic?	Less than once a week	83(24.0)	108	80	271	
	Once a week	137	115	105	357	
	Two to three times a week	(39.6) ^a	(28.1) ^a	(33.2)	(33.3)	
	Three to seven times a week	84	130	115	329	
	I rely solely on delivery services	(24.3) ^a	(31.8)	(36.4) ^a	(30.8)	
	Total	346	409	316	1071	
	(32.3)	(38.2)	(29.5)	(10.4)		
Would you continue to shop for food at the same pace when the pandemic would be over?	Yes	144	132	96	372	
	No	(41.6) ^{ab}	(32.2) ^a	(30.2) ^b	(34.6)	
	Maybe	97(28.0)	110	74	281	
		(26.8)	(23.3)	(26.2)		
		105	168	148	421	
		(30.4) ^{ab}	(41.0) ^a	(46.5) ^b	(39.2)	
		346	410	318	1074	
		(32.2)	(38.2)	(29.6)		

Values in the same row with similar superscript are significantly different (p < 0.05).

3.1.2. Ordering RTE food delivery before and during the pandemic

Wilcoxon signed-rank test showed that the pandemic had caused a significant change in respondents' food consumption behavior as shown in the reduced frequency of ordering hot RTE foods ($Z = -17.798$, $p = 0.000$) and cold RTE food ($Z = -13.379$, $p = 0.000$). These changes were commonly observed in the three countries for the hot and cold RTE food with values for Lebanon ($Z = -12.444$, $p = 0.000$ and $Z = -9.571$, $p = 0.00$), Jordan ($Z = -11.374$, $p = 0.00$ and $Z = -8.737968$, $p = 0.000$), and Tunisia ($Z = -5.598$, $p = 0.00$ and $Z = -3.441$, $p = 0.000$) (Supplementary materials- Fig. 1a–b). Overall, there was a significant rise from 14.1% to 33.3% and 24.4%–36.6% in the proportion of those who stopped ordering hot and cold RTE food delivery during the pandemic, respectively (Table 3) with the Lebanese showing a significantly reduced consumption of RTE foods compared to their counterparts. Nonetheless, the Tunisian respondents showed lower consumption levels before and during the pandemic than the Lebanese and Jordanians because online or direct order for RTE food delivery is not widespread in Tunisia where consumers prefer home-made food products for hygiene and taste reasons (Zaibet et al., 2004). The delivery services for cold RTE food are not very common in the studied countries, explaining the wide gap in the consumption levels between the cold and hot RTE foods.

These data indicate that food choices were affected by fear of food as a potential vector of the COVID-19 virus. This was observed as we explored the frequency of RTE food consumption among the respondents who mainly reported extreme and moderate levels of concern about getting infected from eating food that may be contaminated with the SARS-CoV-2 (Faour-Klingbeil et al., 2021).

Our study is in line with the recently published results of the consumer survey on COVID-19's impact on food purchasing, eating behaviors, and food safety perceptions (IFIC, 2020). The report shows that people were doing less shopping in-person and cooking more. When asked how their food shopping habits have changed over the past month, half of all survey takers reported shopping in-person less, and nearly half (47%) of survey takers said that they were eating more home-cooked meals than one month ago. Nearly 1 in 3 reported that they were ordering less takeout or delivery than usual, while 16% said they were ordering more often than they used to (IFIC, 2020). Likewise, in China,

Table 3

The frequency of ordering ready-to-eat food delivery before and during the pandemic.

Statement	Frequency	Lebanon	Jordan	Tunisia	TOTAL
		N (%) ^a	N (%) ^a	N (%) ^a	N ^b
Delivery of hot ready-to-eat food before the pandemic	Never	54 (15.7) ^a	31 (7.6) ^{ab}	63 (21.1) ^b	148 (14.1)
	No access to food delivery services	11 (3.2) ^{ab}	44 (10.8) ^{ac}	92 (30.9) ^{bc}	147 (14.0)
	Less than once a week	122 (35.4) ^a	153 (37.7) ^b	76 (25.5) ^{ab}	351 (33.5)
	Once a week	75(21.5)	79 (19.5)	44 (14.8)	198 (18.9)
	Twice a week	50 (14.5) ^a	47 (11.6) ^b	9(3.0) ^{ab}	106 (10.1)
	More than twice a week	33(9.6)	52 (12.8) ^a	14(4.7) ^a	99 (9.4)
	Total	345 (32.9)	406 (38.7)	298 (28.4)	1049
Delivery of hot ready-to-eat food during the pandemic	Never	177 (51.9) ^{ab}	91 (22.6) ^a	75 (26.0) ^b	343 (33.3)
	No access to food delivery services	37 (10.9) ^{ab}	112 (27.9) ^{ac}	108 (37.5) ^{bc}	257 (25.0)
	Less than once a week	93(27.3)	137 (34.1)	76 (26.3)	306 (29.6)
	Once a week	19(5.6)	36(8.9)	24(8.3)	79(7.7)
	Twice a week	12(3.5) ^a	16(4.0) ^b	1(0.3) ^{ab}	29 (2.8)
	More than twice a week	3(0.9)	10(2.5)	4(1.4)	17(1.6)
	Total	341 (33.1)	402 (39.0)	288 (27.9)	1031
Delivery of cold food before the pandemic	Never	128 (37.5) ^{ac}	54 (13.4) ^a	70 (24.4) ^c	252 (24.4)
	No access to food delivery services	28(8.2) ^a	76 (18.8) ^{ab}	110 (38.3) ^{ab}	214 (20.7)
	Less than once a week	105 (30.8)	146 (36.1) ^a	68 (23.7) ^a	319 (31.0)
	Once a week	46(13.5)	64 (15.8)	29 (10.1)	139 (13.5)
	Twice a week	22(6.5)	31(7.7)	0 (0.0)	53 (5.1)
	More than twice a week	12(3.5) ^a	33 (8.2) ^{ab}	10(3.5) ^b	55 (5.3)
	Total	341 (33.0)	404 (39.1)	287 (27.9)	1032
Delivery of cold food during the pandemic	Never	209 (61.3) ^{ab}	92 (23.0) ^a	73 (25.6) ^b	374 (36.6)
	No access to food delivery services	48 (14.0) ^a	122 (30.6) ^{ab}	114 (40.0) ^{ab}	284 (27.7)
	Less than once a week	65 (19.1) ^a	132 (33.1) ^a	73 (25.6)	270 (26.3)
	Once a week	14(4.1)	29(7.3)	19(6.7)	62 (6.0)
	Twice a week	5(1.5)	15(3.7) ^a	1(0.4) ^a	21 (2.0)
	More than twice a week	0 (0.0)	9(2.3)	5(1.7)	14 (1.4)
	Total	341 (33.3)	399 (38.9)	285 (27.8)	1025

Values in the same row with similar superscript are significantly different ($p < 0.05$).

^a % of the total respondents in each country.

^b % of the total sample size N of the three countries.

as a result of the increased frequency of food scares in recent years and the increased Chinese consumers' worries about food safety, consumers' confidence in the quality of food was reduced which led to a drop in demand for certain food products (Liu et al., 2013).

On the contrary, behaviors regarding food delivery and grocery delivery in Qatar and UAE have increased by 30% and 25% compared to pre-COVID-19 times, respectively. In UAE, 33% and 36% of consumers use more grocery and restaurant delivery during the pandemic (McKinsey & Company, 2020). The behavioral divergence between

consumers in the Gulf Cooperation Council (GCC) Countries and the surveyed countries is expected considering the different social and cultural aspects of Gulf countries and other Arab countries of the MENA region. GCC countries tend to have affluent populations outnumbered by expatriates who can afford food deliveries. Besides, in major cities such as Dubai with busy work schedules and heavy traffic, people find home delivery an ideal option instead of home preparation or eating out (KPMG, 2020). Food delivery and online food delivery is well established in the UAE long before the Coronavirus pandemic. The delivery segment is still growing every year, and with the advent of cutting-edge technology, the on-demand food delivery is already possible; more than 60% of users in Dubai have one or more food delivery apps installed in their smartphones, and around 50% use them to order online (KPMG, 2020).

3.2. Hygiene practices during and before the pandemic

The frequency of the hygiene practices and habits of respondents from the three countries have changed significantly during the pandemic. Wilcoxon signed-rank test values were $Z = -19.264$, $p = 0.000$ for the variable "Dispose of all food and RTEs shopping bags", $Z = -19.634$, $p = 0.000$ for "Dispose of all boxes and packages of food", $Z = -21.453$, $p = 0.000$ for "Disinfection of food packaging", $Z = -19.415$, $p = 0.000$ for "Washing hands after touching food bags and packages", $Z = -16.334$, $p = 0.000$ for "Washing hands after returning home", $Z = -10.132$, $p = 0.000$ for "Washing hands before preparing food".

Compared to the pre-COVID-19 times, a significantly higher number of people were practicing handwashing before food handling, when returning home, and after touching food packages during the outbreak. However, this significance is primarily attributed to a 32.2% and 24.1% increase in frequent handwashing practices after touching food packages and bags and returning home, respectively (Tables 4 and 5). Although frequent hand washing is one of the most campaigned and recommended practices for protection from getting Covid-19, only an 11.2% increase in reported frequent handwashing before food preparation was observed. Additionally, the data show a rise of 22–23% increase in behaviors related to the frequent disposal of the RTE food shopping bags and of food boxes and packages during the pandemic, respectively, besides a 31% increase in disinfection of food packaging before storing at home when compared to pre-COVID times in the three countries (Tables 4 and 5).

At the country level, there were significant differences between Jordan and Lebanon regarding disposing of all RTE shopping bags ($p = 0.004$), and between both, Jordan and Lebanon, and Tunisia and Lebanon ($p = 0.00$ for both) for disposing of all boxes and covers of food, disinfection of food packaging, and washing hands after touching food bags, after returning home and before preparing food. Furthermore, the Lebanese tended to follow much more frequent precautionary measures and handwashing practices during the pandemic than their counterparts (Table 5). One-way ANOVA test showed that respondents in Lebanon followed a significantly higher frequency of protective and hygiene practices to guard against the SARS-CoV-2 across all the tested variables. This difference was noticeable in the disinfection of food packages and disposing of food and shopping bags (Table 6).

Locally, many of the information from the international sources (Center for Food Safety & Applied Nutrition, 2020a, 2020b; WHO, 2020) was shared on some local news platforms indicating that there are no reports or evidence of the virus being transmitted through food or food packaging since the route of transmission and infection is primarily respiratory; however, indirect contact with contaminated surfaces and objects would also play a role in transmission (Al Hurra, 2020; Nesan; News, 2020; Nidaa al watan, 2020; République Tunisienne Ministère de la Santé, 2020). Thus, to minimize the risk from touching food potentially exposed to coronavirus, handling of packages and goods should be followed by hand washing or using hand sanitizer (Seymour et al., 2020). However, the continuing outbreak of COVID-19 prompted most

Table 4The percentage distribution of the protection measures and hygienic practices **before the pandemic**.

Statement	Frequency	Lebanon	Jordan	Tunisia	TOTAL N (%) ^b
		N (%) ^a	N (%) ^a	N (%) ^a	
Dispose of all food and ready-to-eat foods shopping bags	Never	79 (23.1) ^a	90 (22.3)	38 (12.2) ^a	207 (19.6)
	Rarely	82 (24.0) ^a	131 (32.5) ^{ab}	65 (20.9) ^b	278 (26.4)
	Sometimes	87 (25.4) ^a	92 (22.8) ^b	115 (37.0) ^{ab}	294 (27.8)
	Often	52 (15.2)	54 (13.4) ^a	65 (20.9) ^a	171 (16.2)
	Always	42 (12.3)	36 (9.0)	28 (9.0)	106 (10.0)
	Total N	342 (32.4)	403 (38.2)	311 (29.4)	1056
Dispose of all boxes, packages, and covers of food	Never	85 (24.9) ^{ab}	68 (17.0) ^{ac}	28 (9.0) ^{bc}	181 (17.2)
	Rarely	92 (27.0) ^a	105 (26.1)	59 (19.0) ^a	256 (24.3)
	Sometimes	77 (22.6) ^a	85 (21.1) ^b	96 (31.0) ^{ab}	258 (24.5)
	Often	45 (13.2) ^{ab}	83 (20.6) ^a	82 (26.5) ^b	210 (19.9)
	Always	42 (12.3)	61 (15.2)	45 (14.5)	148 (14.1)
	Total N	341 (32.4)	402 (38.2)	310 (29.4)	1053
Disinfection of food packaging before storing at home	Never	129 (38.1) ^a	98 (24.4) ^{ab}	106 (34.0) ^b	333 (31.6)
	Rarely	88 (26.0)	119 (29.6)	75 (24.1)	282 (26.8)
	Sometimes	55 (16.2)	70 (17.4)	70 (22.4)	195 (18.5)
	Often	36 (10.6)	61 (15.2)	40 (12.8)	137 (13.0)
	Always	31 (9.1) ^a	54 (13.4) ^a	21 (6.7) ^a	106 (10.1)
	Total N	339 (32.2)	402 (38.2)	312 (29.6)	1053
Washing hands after touching food bags or packages	Never	36 (10.6)	45 (11.1)	34 (11.1)	115 (11.0)
	Rarely	53 (15.5)	68 (16.8)	57 (18.6)	178 (16.9)
	Sometimes	70 (20.5) ^a	88 (21.8)	88 (28.8) ^a	246 (23.4)
	Often	63 (18.5) ^a	109 (27.0) ^a	76 (24.8)	248 (23.6)
	Always	119 (34.9) ^{ab}	94 (23.3) ^a	51 (16.7) ^b	264 (25.1)
	Total N	341 (32.5)	404 (38.4)	306 (29.1)	1051
Washing hands after returning home	Never	11 (3.2)	22 (5.5)	13(4.2)	46 (4.3)
	Rarely	33 (9.7)	39 (9.7)	31 (10.0)	103 (9.8)
	Sometimes	53 (15.5)	60 (14.9) ^a	70 (22.5) ^a	183 (17.3)
	Often	79 (23.1) ^{ab}	135 (33.6) ^a	118 (37.9) ^b	332 (31.5)
	Always	166 (48.5) ^{ab}	146 (36.3) ^a	79 ^b (25.4) ^b	391 (37.1)
	Total N	342 (32.4)	402 (38.1)	311 (29.5)	1055
Washing hands before preparing food	Never	6 (1.8)	19 (4.8)	6 (1.9)	31 (3.0)
	Rarely	10 (3.0)	20 (5.0)	19 (6.2)	49 (4.7)
	Sometimes	24 ^{ab} (7.1)	50 ^a (12.5)	46 ^b (14.9)	120 (11.5)
	Often	60 ^{ab} (17.7)	140 ^a (35.1)	129 ^b (41.9)	329 (31.5)
	Always	238 ^{ab} (70.4)	170 ^a (42.6)	108 ^b (35.1)	516 (49.3)
	Total N	338 (32.3)	399 (38.2)	308 (29.5)	1045

Values in the same row with similar superscript are significantly different ($p < 0.05$).^a % of the total respondents in each country.^b % of the total sample size N of the three countries.

people to take strict precautionary measures to prevent the virus, on top of which is the purchase and storage of hand sanitizers, face masks. At the same time, it made people increasingly question the risks and possibility of its transmission through food or food packages, mainly when the channels of information conveyed contradictory messages.

Fifty-two percent of the respondents reported moderate to extreme concerns about getting infected from contaminated food packages (Faour-Klingbeil et al., 2021). These concerns were likely to have been exaggerated with the uncertainties around the new virus and frequent advice for chlorine disinfection of food packages (Al Araby, 2020). Experts warned that purchases should be cleaned before entering home referring to research findings on the virus survival on plastic or cardboard surfaces for several days, especially if they are in cold temperatures (NIH, 2020; Public Health Agency of Canada, 2020). Transmission appears to be possible if the virus is transferred shortly afterwards via the hands or the food itself to the mucous membranes of the mouth, throat, or eyes (The German Federal Institute for Risk Assessment, 2020).

3.3. Cleaning agents used in washing FFV

3.3.1. The trend of using cleaning agents besides water before and during the pandemic

Wilcoxon tests showed a significant increase in the frequency of

using different cleaning agents (described in the next section) besides water to wash FFV during the pandemic in the three countries compared to the pre-COVID-19 times ($Z = -15.448$, $p = 0.000$). The results also revealed significant differences in FFV washing practices among the three countries ($p = 0.000$). The Lebanese recorded higher levels of use of cleaning agents than the Tunisians and Jordanians (Table 7). Relative to the pre-pandemic times, the number of Tunisians who always used cleaning agents almost doubled during the pandemic with a 22.3% increase in practice, besides a 16.0% and 26.1% rise in the practice observed among the Jordanian and Lebanese groups, respectively (Table 7). This increasing trend of washing FFV with other cleaning solutions than water indicates adopting a protective practice due to public concerns about getting infected from eating SARS-CoV-2 contaminated food (Faour-Klingbeil et al., 2021) and limited trust or access to clear information on the food-associated risks.

3.3.2. The type of cleaning agents used in washing FFV during the pandemic

For protection from COVID-19, a large number of respondents ($n = 730$) reported the use of vinegar in cleaning FFV, with almost half of them ($n = 305$) and ($n = 332$) were engaged in high-risk practices as they reported the use of soaps and chlorine bleach solution, respectively. (Fig. 1). It is of great concern that more than a third (36%) of the respondents stated that they do not follow instructions or specific guidelines regarding the appropriate concentration while very few (<1%)

Table 5
The percentage distribution of the protection measures and hygienic practices during the pandemic.

Statement	Frequency	Lebanon	Jordan	Tunisia	TOTAL
		N (%) ^a	N (%) ^a	N (%) ^a	N (%) ^b
Dispose of all food and ready-to-eat foods shopping bags	Never	30 (8.7) ^a	33 (8.1%) ^b	11 (3.5%) ^{ab}	74 (7.0)
	Rarely	23 (6.7)	42 (10.3%)	17 (5.4)	82 (7.7)
	Sometimes	55 (16.0)	77 (18.9%)	72 (23.0)	204 (19.2)
	Often	91 (26.6) ^a	140 (34.4%)	132 (42.0) ^a	363 (31.1)
	Always	144 (42.0) ^{ab}	115 (28.3) ^a	82 (26.1) ^b	341 (32.0)
Total N	343 (32.2)	407 (38.3)	314 (29.5)	1064	
Dispose of all boxes, packages, and covers of food	Never	15 (4.4)	21 (5.2)	9 (3.0)	45 (4.3)
	Rarely	21 (6.1)	39 (9.7)	20 (6.6)	80 (7.6)
	Sometimes	43 (12.6) ^{ab}	77 (19.1) ^a	62 (20.3) ^b	182 (17.3)
	Often	85 (24.9) ^a	135 (33.4) ^a	137 (44.9) ^a	357 (34.0)
	Always	178 (52.0) ^{ab}	132 (32.7) ^a	77 (25.2) ^b	387 (36.8)
Total N	342 (32.5)	404 (38.4)	305 (29.1)	1051	
Disinfection of food packaging before storing at home	Never	14 (4.1) ^a	31 (7.7)	28 ^a (9.0)	73 (6.9)
	Rarely	15 (4.4) ^{ab}	36 (8.9) ^a	33 (10.5) ^b	84 (7.9)
	Sometimes	29 (8.5) ^{ab}	72 (17.8) ^a	63 (20.1) ^b	164 (15.5)
	Often	75 (21.9) ^{ab}	125 (30.9) ^a	103 (32.9) ^b	303 (28.6)
	Always	210 (61.2) ^{ab}	140 (34.7) ^a	86 (27.5) ^b	436 (41.1)
Total N	343 (32.4)	404 (38.1)	313 (29.5)	1060	
Washing hands after touching food bags or packages	Never	2 (0.6) ^a	16 (3.9) ^{ab}	3 (1.0) ^b	21 (2.0)
	Rarely	5 (1.5) ^a	19 (4.7) ^a	10 (3.2)	34 (3.2)
	Sometimes	9 (2.6) ^{ab}	34 (8.4) ^a	38 ^b (12.2)	81 (7.7)
	Often	51 (14.9) ^{ab}	137 (33.7) ^a	127 (41.0) ^b	315 (29.8)
	Always	275 (80.4) ^{ab}	200 (49.3) ^b	132 (42.6) ^b	607 (57.3)
Total N	342 (32.3)	406 (38.4)	310 (29.3)	1058	
Washing hands after returning home	Never	1 (0.3) ^a	16 (4.0) ^{ab}	2 (0.6) ^b	19 (1.8)
	Rarely	2 (0.6)	9 (2.2)	7 (2.2)	18 (1.7)
	Sometimes	8 (2.4) ^{ab}	28 (6.9) ^a	29 (9.3) ^b	65 (6.1)
	Often	49 (14.4)	137 (33.9) ^a	122 (39.0) ^a	308 (29.2)
	Always	279 (82.3) ^{ab}	214 (53.0) ^a	153 (48.9) ^b	646 (61.2)
Total N	339 (32.1)	404 (38.3)	313 (29.6)	1056	
Washing hands before preparing food	Never	2 (0.6) ^a	18 (4.4) ^{ab}	3 (1.0) ^b	23 (2.2)
	Rarely	0 (0.0)	13 (3.2)	4 (1.3)	17 (1.6)
	Sometimes	10 (2.9) ^{ab}	35 (8.6) ^a	28 (9.1) ^b	73 (6.9)
	Often	52 (15.2) ^{ab}	131 (32.3) ^a	121 (39.1) ^b	304 (28.8)
	Always	278 (81.3) ^{ab}	209 (51.5) ^a	153 (49.5) ^b	640 (60.5)
Total N	342 (32.4)	406 (38.4)	309 (29.2)	1057	

Values in the same row with similar superscript are significantly different (p < 0.05).

^a % of the total respondents in each country.

^b % of the total sample size N of the three countries.

Table 6
Mean scores of the frequency of protection measures and hygienic practices during the pandemic.

	Country	N	Mean ^a	SD
Dispose of all food and ready-to-eat foods shopping bags	Lebanon	343	3.86 ^a	1.27
	Jordan	407	3.64 ^a	1.22
	Tunisia	314	3.82	0.99
	Total	1064	3.77	1.18
Dispose of all boxes, packages, and covers of food	Lebanon	342	4.14 ^{ab}	1.13
	Jordan	404	3.79 ^a	1.15
	Tunisia	305	3.83 ^b	0.98
	Total	1051	3.91	1.11
Disinfection of food packaging before storing at home	Lebanon	343	4.32 ^{ab}	1.07
	Jordan	404	3.76 ^a	1.23
	Tunisia	313	3.59 ^b	1.24
	Total	1060	3.89	1.22
Washing hands after touching food bags or packages	Lebanon	342	4.73 ^{ab}	0.64
	Jordan	406	4.20 ^a	1.04
	Tunisia	310	4.21 ^b	0.85
	Total	1058	4.37	0.90
Washing hands after returning home	Lebanon	339	4.78 ^{ab}	0.54
	Jordan	404	4.30 ^a	0.98
	Tunisia	313	4.33 ^b	0.78
	Total	1056	4.46	0.83
Washing hands before preparing food	Lebanon	346	4.71 ^{ab}	0.75
	Jordan	410	4.19 ^a	1.11
	Tunisia	318	4.23 ^b	1.05
	Total	1074	4.37	1.02

Mean scores in the same column with the same superscript letter are significantly different (p < 0.05).

^a Mean score of the respondents' attitudes on a 5-Likert scale: 5 "Always", 4 "Often", 3 "Sometimes", 2 "Rarely", 1 "Never".

reported that they relied on their hunch. Besides vinegar, the soaps were mostly used by the Lebanese and Jordanian respondents to clean their FFV during the pandemic, whereas a higher proportion of Tunisians used chlorine bleach solution (Fig. 1).

Table 7
The frequency of use of cleaning agents besides washing fresh fruits and vegetables before and during the pandemic.

The use of cleaning agents	Frequency	Country			Total N
		Lebanon	Jordan	Tunisia	
		N (%)	N (%)	N (%)	
Before the pandemic	Never	23 (6.7) ^a	56 (14.0) ^a	31 (10.0)	110
	Rarely	32 (9.3) ^a	57 (14.1) ^b	68 (21.8) ^{ab}	157
	Sometimes	67 (19.5) ^a	113 (28.0) ^a	114 (36.7) ^a	294
	Often	88 (25.7)	84 (20.8)	61 (19.6)	233
	Always	133 (38.8) ^a	93 (23.1) ^a	37 (11.9) ^a	263
Total	343 (32.5)	403 (38.1)	311 (29.4)	1057	
During the pandemic	Never	18 (5.3)	39 (9.7)	19 (6.2)	76
	Rarely	9 (2.6) ^{ab}	31 (7.7) ^a	29 (9.4) ^b	69
	Sometimes	35 (10.2) ^a	71 (17.7) ^a	93 (30.3) ^a	199
	Often	58 (17.0) ^a	103 (25.7) ^a	61 (19.9)	222
	Always	222 (64.9) ^{ab}	157 (39.2) ^a	105 (34.2) ^b	484
Total	342 (32.6)	401 (38.2)	307 (29.2)	1050	

Values in the same row with the same superscript letter are significantly different (p < 0.05).

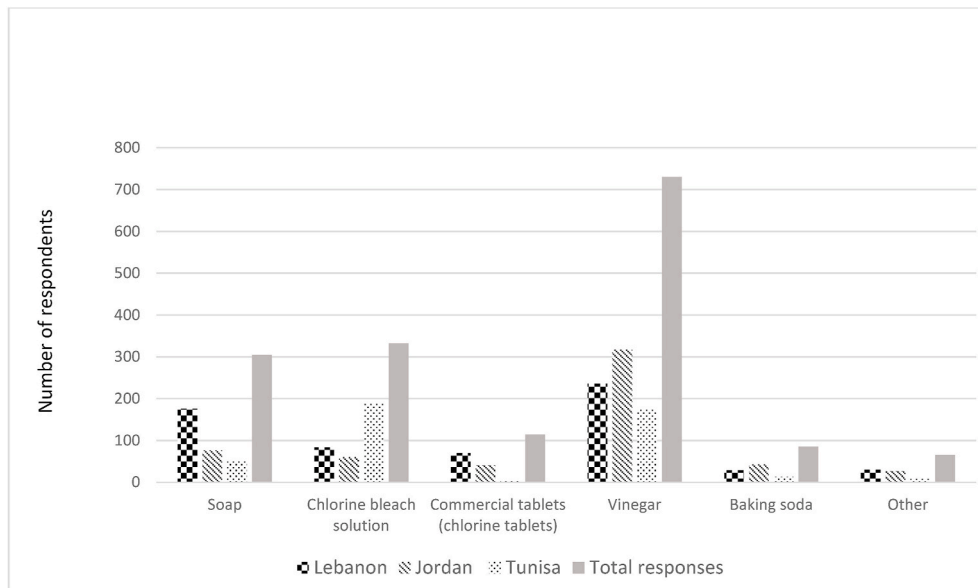


Fig. 1. The level of use of cleaning agents for washing fresh fruits and vegetables in the three countries, Data is presented as number of responses obtained on a multiple-choice question. a. The frequency of ordering hot RTE food delivery before and during the pandemic. b. The frequency of ordering cold RTE food delivery before and during the pandemic.

These practices stemmed from limited knowledge and lack of information on safer practices and effective methods for safe handling of FFV. Vinegar is well proven for its antimicrobial properties and inhibitory effects against pathogenic bacteria on fresh fruits and vegetables (Yagnik et al., 2018), yet it is not effective on coronavirus. On the other hand, sodium hypochlorite is among the effective disinfectants that inactivate the coronavirus in fruits and vegetables (e.g., chlorine dioxide, sodium hypochlorite, quaternary compound, ozone, and UV-C) (Quevedo et al., 2020). However, the excessive use of chlorine bleach solution and most likely not the food-grade chlorine, being not quite common in the studied countries, poses health risks. Chlorine bleach is a widespread chemical product that is highly used in some countries of the Arab region for hygiene purposes such as cleaning toilet floors and fittings unaware of its impact on health when misused or mixed with other solutions (Agence de Promotion de l'Industrie et de l'Innovation., 2018). Although reported by only very few, other hazardous compounds such as Dettol and liquid detergents were also used as a cleaning agent to protect against the COVID-19 virus. These practices can have an impact on public health and pose a risk of severe tissue damage and corrosive injury (Gharpure, 2020; Slaughter et al., 2019).

There is no evidence that food is a route of transmission of SARS-CoV-2. However, the coronavirus transmission to fresh fruits and vegetables through an infected person via sneezing or coughing directly on them suggested caution in washing FFV unless they are cooked (French National Academy of Medicine, 2020). On the other hand, the CDC reported that there is an increase in chemical-related health issues caused by the misuse of disinfectants by people trying to reduce the risk of COVID-19; thirty-nine percent of surveyed subjects reported intentionally engaging in at least one high-risk practice not recommended by CDC for prevention of SARS-CoV-2 transmission, including the application of bleach to food items (e.g., fruits and vegetables) (19%); use of household cleaning and disinfectant products on hands or skin (18%); misting the body with a cleaning or disinfectant spray (10%); inhalation of vapors from household cleaners or disinfectants (6%); and drinking or gargling diluted bleach solutions, soapy water, and other cleaning and disinfectant solutions (4% each) (Gharpure, 2020). According to CDC, washing fruits and vegetables with soap, detergent, or commercial produce wash is not recommended; neither is the use of bleach solutions or other disinfecting products on food (CDC, 2020c). However, in some countries

like Lebanon where water pollution reached dangerous levels (Massena, 2017), cleaning agents on FFV including chlorine solutions might be used for reducing microbial hazards, yet, these should only be applied according to directions of use and recommendations on their specific application.

4. Limitation

Our study has two main limitations. As the Internet use in the studied countries is still low compared to developed countries, identifying potential samples for the web-based survey and reaching out for a larger sample size while avoiding a skewed sample was not an easy task. Several researchers have also examined the low response rates of many online surveys (Schonlau et al., 2002; Wilson & Laskey, 2003). The studied population comprised a high proportion of educated respondents which is unlikely to represent the general Lebanese, Jordanian, and Tunisian populations. In this case, generalizing the findings is not accurate. Nevertheless, the current results provided insight into risky practices and changes in hygiene and shopping behavior of an existing Arab population segment. These findings will serve as baseline information to compare data from different areas in the Arab region to enhance COVID-19 prevention messages.

There are significant variations in the availability and access to technological tools and connectivity across Arab countries with low- and middle-income countries at a disadvantage (Arab Center Washington, 2020; UNESCWA, 2019); hence, people in rural areas or from low economic status with limited access to the internet have not been studied in this work. Based on our results, we believe that risky practices related to food or non-compliance with preventive measures are likely to be an issue and warrant further research.

Besides, behavioral changes related to glove use and masks were not covered in this study as the focus was on hygienic practices in the context of food handling and purchasing during the pandemic. Investigating the former could shed light on the effect of the containment policies and public compliance.

5. Conclusion

COVID-19 pandemic has resulted in significant changes in food

shopping, food handling, and hygiene practices of the surveyed subjects in Lebanon, Jordan, and Tunisia. The study sample showed a significant rise in their adoption of precautions and hygiene measures for the coronavirus such as disposing of food packages as well as RTE food and grocery shopping bags and disinfecting food packages before storing at home. Although people practiced handwashing much more frequently during the pandemic, the proportion level was lower than expected, particularly before food preparation. Food choices were also affected as seen in the substantial reduction in ordering RTE hot and cold food and food shopping frequency.

Obviously, misinformation or lack of information is a prevalent issue in the studied countries where a great majority reported vinegar use despite its well-known ineffectiveness in eliminating the virus. Moreover, considering the uncertainties surrounding the virus, concerns about SARS-CoV-19 transmission through food have led people to adopt or intensify pre-COVID-19 existing practices in a manner that could pose health risks, e.g., using chlorine bleach, cleaning detergents, and soaps for washing FFV without following instructions for appropriate use.

The findings underscored the importance of clear and targeted messages in risk communication. Risk communication should not be restricted to sharing general recommendations and warnings, rather tailored to the public's specific needs, and based on their risk perceptions and reactions. For instance, unreasonable alarming behavioral issues have been recorded in the United States where the ingestion of disinfectants was a matter of postulation. The CDC was prompted to counteract such dangerous fallacies by releasing guidance to the public and facts messages. It is known that the CDC based the messaging on information shared on social media. The latter has been quite effective for many agencies such as the WHO to share prevention messages; however, it has also encouraged spreading rumors and coronavirus myths. Social media was a chief source of information for the surveyed subjects. Although local authorities in Lebanon, Jordan, and Tunisia have taken several measures to manage the outbreak in the best possible way through local announcements, news broadcasting, health messages on official websites, and initiatives, e.g., the cooperation of the United Nations Development Program in Lebanon to fight misinformation about the coronavirus, the exposure to inaccurate information can continue to influence people beliefs, and this requires concerted efforts to dispel rumors and guide the public using simple prevention messages consistent with the current scientific understanding.

In such a crisis, local authorities shall establish a mechanism to capture and identify misconceptions. It is essential to coordinate efforts with all concerned stakeholders to establish reliable sources of information. Further, local authorities shall communicate the benefits of (a) frequent hand hygiene, (b) health effects of haphazard use of chemicals on food, and (c) importance of appropriate use of cleaning agents, i.e., following use instructions on their labels. This will ensure overall safer practices and reduce health risks.

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CRediT authorship contribution statement

Dima Faour-Klingbeil: Conceptualization, Methodology, Formal analysis, Investigation, Writing - original draft. **Tareq M. Osaili:** Investigation, Writing - original draft. **Anas A. Al-Nabulsi:** Investigation, Writing - original draft. **Monia Jemni:** Investigation, Writing - original draft. **Ewen C.D. Todd:** Writing - review & editing, Supervision.

Declaration of competing interest

None

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Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.foodcont.2021.107934>.

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