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Food Control 139 (2022) 109073

Contents lists available at ScienceDirect

Food Control

journal homepage: www.elsevier.com/locate/foodcont

How has public perception of food safety and health risks changed a year after the pandemic and vaccines roll out?

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ARTICLE INFO

Keywords:
COVID-19
SARS-CoV-2
Food safety perception
Hygiene practices
Health risks
Vaccination
MENA

ABSTRACT

The recent coronavirus pandemic (COVID-19) has caused unprecedented turmoil and spurred fears that have profoundly changed the public's social and health behaviours, including the perception of food safety risks. One year after the pandemic and the global vaccination campaign, the public perception of food safety and the changes in their hygiene behaviour, health risks concerns, and trust were studied in Jordan, Lebanon, and Tunisia using a cross-sectional online survey. The results of 538 subjects showed a rise in the frequency of hygiene practices, notably in handwashing. Sixty-four percent of the participants were vaccinated, a proportion made up mainly of the Jordanians and Lebanese. For 66% and 64% of the two population groups, respectively, there were no longer trust concerns about COVID-19 health risks following vaccination, whereas the worries about getting COVID-19 persisted for others. Only 47% of participants trusted eating food prepared by vaccinated food handlers. A great majority of the Tunisians (81%) showed varying degrees of concern about COVID-19 transmission from food and the lowest vaccination rate (33%). The current study demonstrated that the impact of vaccination policy positively affects public perception of food-related risks during the pandemic. On the other hand, 33% of the surveyed Jordanians and Tunisians lost trust in the health authorities' management of the pandemic, and 45% of the Lebanese still don't trust them. Communication strategies on health and food safety with the public still represent a challenge for these and probably other countries in the Middle East and North Africa (MENA). Strategies for building and maintaining public trust are crucial to curb persistent fear of food, hence, avoiding potential stigmatization affecting the food economy by promoting health awareness and positive changes in food safety perceptions for safer practices.

1. Introduction

The 21st century witnessed a revolutionary process in the medical field, and biomedical technologies harnessed to identify health issues and diagnose diseases allowing rapid advances in treatments. Since 1900, the average lifespan of persons in the United States has lengthened by greater than 30 years; 25 years of this gain are attributable to advances in public health (MMWR, 1999). Yet, according to the 2017 Tracking Universal Health Coverage-Global Monitoring Report, half the world still lacks access to essential health services, and each year 800 million are burdened with paying for their health, and for 100 million, these expenses are pushing them into poverty line (World Bank, 2017). Moreover, the Corona Virus Disease 2019 (COVID-19) declared by the World Health Organization (WHO) as the sixth global health emergency, uncovered the fragilities of many healthcare systems around the world that fell short in staffing and adequate resources such as masks, ventilators, but also disparities in responsiveness to emergencies. The pandemic caused by the severe acute respiratory syndrome coronavirus type 2 (SARS-CoV-2) is ranked as the third in terms of fatal coronavirus diseases, after the severe acute respiratory syndrome coronavirus (SARS-CoV), and the Middle East respiratory syndrome coronavirus (MERS-CoV) (Al-Qahtani, 2020; Siddique et al., 2021). Thus, its severe

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https://doi.org/10.1016/j.foodcont.2022.109073
Received 26 February 2022; Received in revised form 26 April 2022; Accepted 1 May 2022
Available online 4 May 2022

impact on the economy and supply chain vitality and its significant threat to public health is projected to burden many countries for many years to come.

Following the official declaration of the pandemic, extreme measures prevailed globally, although at various paces, to contain the virus, which spreads rapidly from person to person through droplets emitted when sneezing, coughing, or talking. Hence, restricting human movements and social encounters to reduce the spread of the disease have re-shaped lives and habits worldwide (Di Renzo et al., 2020). The widespread use of online platforms for social media has created a multitude of opinions on how to live, such as schooling, shopping, businesses, and virtual conferences. Relative to the pandemic over almost two years, there are divergent opinions on face masking and vaccinations (Taylor & Asmundson, 2021) as people live in fear of the disease; some want to be ultra-cautious, and others want to return to normalcy as quickly as possible.

There are similarities to the Spanish flu epidemic, which occurred in three waves and infected 500 million people in less than one year (Robinson, 2021). However, the illnesses and deaths from the ongoing COVID-19 pandemic may well exceed those from the Spanish Flu, with at least 800.000 deaths in the United States alone. For over 100 years, control of pandemics has continued to fall short despite medical and epidemiological advances during this period. In addition, the length of the pandemic has increased the uncertainty and anxiety among populations, negatively affecting mental health (Auerbach & Miller, 2020) and stressing out overworked healthcare staff (Ananda-Rajah et al., 2021). It also helped destabilize government control, led to increased violence (Aston et al., 2020; Polo, 2020), and decreased the need to maintain democratic principles (Moynihan, 2020).

COVID-19 has imposed various challenges to the food supply chain, including considerable concern about food production, processing, distribution, and demand (Aday & Aday, 2020). For some regions, consumer demand for food and hygienic supplies increased to the extent that some store shelves were temporarily emptied because of excess purchases of essential products in panic buying. However, these concerns go beyond supply and into its safety with the need for the public to accept it is purchasing a safe and reliable food supply worldwide (Aday & Aday, 2020).

As waves of more infectious variants became more frequent throughout the world, the cases of infections and deaths soared to put a severe burden on healthcare systems. The latter resulted in extreme anxiety in many countries and constraining food trade in some (Gale, 2021). Though the national and international health agencies, including the CDC and the WHO, provided guidelines for prevention and emphasized that the COVID-19 virus is not transmitted to humans through food, consumers were still concerned about contracting COVID-19 from food (McFadden et al., 2021). In the initial phase of the pandemic, social media contributed to the public confusion as fallacies around the severity and infectiousness of the virus were circulating with no effective counteracting messages by health agencies. Even though authorities in many countries and the WHO were trying to respond as quickly as possible to counter the propagation of unfounded viral rumors through social media platforms and interviews on news channels, public concerns about food safety during the pandemic were mounting worldwide. This produced a new wave of health-threatening practices such as applying household cleaning or disinfectant products to bare skin and intentionally inhaling or ingesting the cleaners (Gharpure, 2020).

In 2020, the authors of the current study examined the public perception of food and non-food related risks of infections during the early months of the pandemic and their opinions on health authorities' risk communication and management in Lebanon, Jordan, and Tunisia. The results showed that 70% of the surveyed subjects were concerned that COVID-19 is a foodborne disease (Faour-Klingbeil et al., 2021a). Moreover, their perception of risk from touching contaminated surfaces and food packaging and being exposed to infected people during food shopping was even higher. Sixty percent of the surveyed subjects sought their information from social media. However, less than half trusted their local and national authorities' information on COVID-19, risk communication and response to false rumors.

The rapid onset and spread of COVID-19 showed that public health authorities were far from prepared to react to any pandemic as the virus became more embedded in the populations. This is despite the knowledge that early global alerts are necessary to respond with swift preparation and control strategies, enhance the quality and level of information, and counter the propagation of unsubstantiated rumors on the origin and severity of the disease and its transmission and control and risky practices (OECD, 2020). The availability of vaccines and increased understanding of the different strains of the virus and its propagation substantially progressed over 2021. Also, the experience in managing the pandemic through appropriate preventative strategies (social distancing and wearing of face masks in public) were increasingly promoted. However, a portion of the public did not adopt recommended prevention and control measures, partly based on a lack of trust in governmental authorities, including science and sense of self-control, as being more valid than those of others, no matter how qualified they are (Qunaibi et al., 2021). Thus, how far public hygiene behaviour and food-related perception of risks in Lebanon, Jordan, and Tunisia also changed as the pandemic progressed into its second year was questioned.

The current study was designed to explore whether public trust in local authorities' risk management has strengthened and helped with the vaccination campaigns reducing public concerns related to food safety and changing their hygiene practices and measures taken against COVID-19 or not.

2. Materials and methods

2.1. Survey instrument

A previous structured and validated web-based questionnaire was adapted to conduct a cross-sectional survey in the current study (Faour-Klingbeil et al., 2021a; 2021b) with some modifications to frequency scales and additional questions about vaccination to address the research objectives.

The questionnaire consists of three sections:

Section one contained the demographic information of the participants.

Section two comprised nine multiple-choice and close-ended questions on the public perceptions of COVID-19 related health risks, their attitudes towards the vaccination benefits and food safety risks. The questions addressed the vaccination status, whether the participants or any family member contracted COVID-19, and the top and most minor concerns during the pandemic. Moreover, this section rated on a scale of 1 (least worried) to 4 (very worried) the concerns level of eating food prepared by vaccinated food handlers, and on a scale of 1 (much more concerned) to 5 (was not concerned), the level of changes in concerns about the health risks related to COVID-19 compared to the previous year.

Section three comprised three questions focusing on the changes in public trust in the local authorities' risk management and communication as well as their hygiene practices relative to the previous year:

(1) The clarity of information obtained from the health authorities was rated on a scale of 1 (poor) to 4 (excellent);
(2) A multiple-choice question on changes in trust in the local authorities during the pandemic contained a list of possible answers ranging from "I have more trust" to "I still do not trust them".
(3) Respondents indicated the degree of change in particular practices represented by a set of statements related to hygiene practices, protective measures related to food shopping, and consumption of ready-to-eat foods. The frequency scale ranged

from "more frequent" to "not anymore" in comparison with the previous year, with the option of "never followed this practice" to avoid selecting any other answer by chance.

The questionnaire was initially designed in English. To ensure the quality of the translation, native Arabic speakers (one of the researchers) performed a back-translation. The translated version was validated again by the research group members, also native speakers.

The survey and the procedure to be followed were approved by the Ethical Approval Committee of the Institutional Review Board of the Jordan University of Science and Technology in Jordan (Ref.:74/140/2021, date 27.05.2021).

2.2. Survey procedure

2.2.1. Pilot phase

Before initiating the data collection, the survey was piloted with 32 participants from Lebanon, Jordan, and Tunisia to assess the content readability, examine its reliability and questions flow, and test the functionalities of the survey and its link, and the survey's length. The participants were contacted via social media applications (Facebook Messenger and WhatsApp) and emails. The authors followed up with the pilot participants for any feedback and comments necessary to improve the tool. Minor modifications were considered, such as rephrasing a question and adding a question on the vaccination doses. The responses from the pilot testing were not included in this study.

2.2.2. Survey administration and participants' recruitment

A convenience sample of the population (N = 558) with various backgrounds in Lebanon (202), Jordan (201), and Tunisia (155) was recruited for this study (Table 1). The survey was conducted online and anonymously through Google Forms, a survey administration app included in the Google Drive office suite. It is a cloud-based data management tool used for designing and developing web-based questionnaires and provides various options for capturing the data from multiple answers.

The survey instrument was open for participation from June 2021 to September 2021. The first page of the web survey displayed the study details and the anonymous collection of data, including the eligibility criteria and the right of participants to discontinue at any time. Screening questions were used to ensure that participants were over 18 years and resided or lived 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".

The authors initiated the data collection by sending an invitation text to their network via WhatsApp with the survey link. The invitation for participation was also disseminated via other social media platforms, i.e. Facebook and LinkedIn. The sampling relied on the snowball technique, i.e., referrals from initial subjects to generate additional subjects. Participants were encouraged to share the survey link and invite their family, friends, and colleagues. Given the low response rate and the interest in reaching out to a larger sample, the data collection period was extended by reverting to paid Facebook promotional campaigns to target broader audiences above 18 years and living in Lebanon, Jordan, and Tunisia. There was no incentives or financial rewards offered to participants.

Table 1
Sample demographic characteristics.

Total sample size (N = 558)		Country of residence			
		Jordan	Tunisia	Lebanon	Total
		N (%)	N (%)	N (%)	N (%)
		201 (36)	155 (28)	202 (36)	558 (100)
Gender	Female	128 (64)	99 (64)	146 (72)	373 (67)
	Male	73 (36)	56 (36)	56 (28)	185 (33)
	GRAND TOTAL	**201 (36)**	**155 (28)**	**202 (36)**	**558 (100)**
Age	19–24	80 (40)	16 (10)	27 (13)	123(22)
	25–34	43 (21)	57 (37)	50 (25)	150 (27)
	35–44	23 (12)	56 (36)	45 (22)	124 (22)
	45–54	32 (16)	18 (11)	43 (21)	93 (17)
	55–64	17 (8)	4 (3)	24 (12)	45 (8)
	65+	6 (3)	4 (3)	13 (7)	23 (4)
	GRAND TOTAL	**201 (36)**	**155 (28)**	**202 (36)**	**558 (100)**
Education	Less than high school	3(1)	4 (2)	13 (6)	20 (3)
	Specialist/ Professional training	3 (2)	6 (4)	5 (3)	14 (3)
	High school/ Diploma	14 (7)	12 (8)	16 (8)	42 (8)
	Bachelor degree	153 (76)	43 (28)	63 (31)	259 (46)
	Master degree	18 (9)	68 (44)	76 (38)	162 (29)
	Doctorate	10 (5)	22 (14)	29 (14)	61 (11)
	GRAND TOTAL	**201 (36)**	**155 (28)**	**202 (36)**	**558 (100)**

2.3. Statistical analysis

All data were analyzed using the Windows version of SPSS 26, Statistical Package for Social Sciences (SPSS Inc., Chicago, Ill., USA). Descriptive statistical analysis was performed to summarise the socio-demographic characteristics of respondents. Cross tabulations and chi-square tests were used to test for significant association between selected categorical and ordinal variables, such as the level of vaccination and concerns about the health risks of COVID-19. In addition, the Kruskal-Wallis test was performed to examine if changes in the frequency of hygiene and food shopping practices, level of concerns of COVID-19 health risks and food safety, and trust in local authorities' management of the pandemic differed significantly between the three countries. Kruskal-Wallis test is a non-parametric approach to the one-way ANOVA. The procedure compares three or more groups on a dependent variable that is measured on at least an ordinal level. One-Way ANOVA test was also used to compare the mean scores on selected test parameters between countries (i.e., rating the clarity of information obtained on the vaccination from the local authorities). The parametric tests such as Analysis of Variance can be used to summarise the Likert scales rating using means and standard deviations (Norman, 2010).

Additionally, binomial regression was performed to examine the predictive effect of the vaccination (a categorical independent variable) on the public trust in the safety of food prepared by a vaccinated food handler and its concerns of getting COVID-19 through food (dichotomous dependent variables). The latter, initially tested on a five-point Likert scale, was categorized into two groups, (1) Not concerned for participants reporting no concerns at all and (2) Concerned, for responses with varying levels of concerns, i.e., "very concerned", "concerned", and "somewhat concerned".

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 value was 0.74 for all categorical questions, indicating an acceptable internal consistency level.

3. Results and discussion

The socio-demographic characteristics of the surveyed subjects are

shown in Table 1. More than a third of the total sample were surveyed in Jordan (36%) and Lebanon (36%) and slightly less in Tunisia (28%). More than two-thirds of the respondents (67%) were female, with 17% aged between 45 and 54 years; an equal proportion of the sample was distributed across the age groups from 19 to 44 years. In terms of educational level, 94% of the respondents had higher than a high school diploma.

3.1. Public concerns about COVID-19 health risks compared to the previous year and their trust in the benefits of vaccination

About two-thirds of the respondents were vaccinated (64%) (Fig. 1); of those, 81% received two doses, the other 19% had only one. Of the remaining 36% who were unvaccinated, half (18% of the total) felt positive about the vaccination but were still on the waiting list. Between 2 and 10% said they did not want any vaccination even if it was available. Statistical analysis showed a significant difference in the level of vaccination between the different countries. More vaccinated respondents were observed among the Jordanian and Lebanese groups compared to Tunisians ($p < 0.001$). This trend is interestingly in line with studies prior to rolling out of vaccines which showed that 37% of Jordanian, 21% of Lebanese and only 6% of Tunisian people were willing to take the vaccine once available (Kasrine Al Halabi et al., 2021; Qunaibi et al., 2021). The official records for vaccine roll-out show differences in the pace of progress among different countries worldwide. For instance, 21, 12 and 10% of the Jordanian, Lebanese and Tunisian respondents were either fully or partially vaccinated at the time the present study was undertaken in 2021, respectively.

Because of the low vaccination rate among its population, the Tunisian Ministry of Health declared a law for vaccination that took effect in December 2021. The law mandates a COVID-19 vaccine pass to access public places and attend public events (Ministère de la santé publique, 2021). A similar law was promulgated in Jordan on September 5, 2021 (Jordanian Ministry of Health, 2021). In Lebanon, mandatory vaccination for all civil servants and workers in the health, education, tourism and public transport sectors took effect as of January 10, 2022 (The national news, 2021).

Qunaibi et al. (2021), in a large-scale survey on Arabs in and outside the Arab region, found that safety and efficacy concerns, mistrust of scientific research, mistrust of ingredients and fear of potential side effects were the most common reasons for vaccine hesitancy.

When asked to compare their concerns to a prior year, more than a third of the respondents reported being less concerned (42%) and only 13% were not any more concerned about getting infected with the coronavirus, (Table 2). In contrast, only 14% became more worried and less than a third (26%) were still concerned about COVID-19 (Table 2).

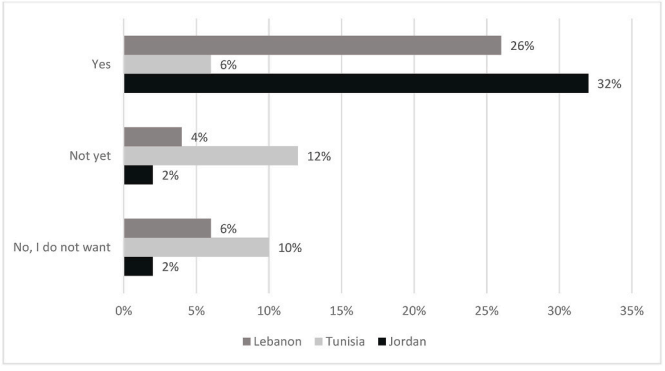

Fig. 1. The percentage distribution of vaccinated and unvaccinated respondents by country
The values are % of the total sample size.
* Not yet =
I want, I am on the waiting list.

Table 2
Public concerns about the health risks of COVID-19 compared to the previous year.

	Country of residence			
	Jordan N (%)[a]	Tunisia N (%)[a]	Lebanon N (%)[a]	Grand Total N (%)
More concerned	14 (7)$_a$	43 (28)$_b$	18 (9)$_a$	**75 (14)**
Still concerned	43 (21)$_a$	52 (34)$_b$	51 (25)$_{ab}$	**146 (26)**
Less concerned	92 (46)$_a$	44 (28)$_b$	97 (48)$_a$	**233 (42)**
Not anymore concerned	42 (21)$_a$	11 (7)$_b$	22 (11)$_b$	**75 (13)**
Have not been concerned, still not	10 (5)$_a$	5 (3)$_a$	14 (7)$_a$	**29 (5)**
Total N (%)	201 (100)	155 (100)	202 (100)	
Grand Total	**201 (36)**	**155 (28)**	**202 (36)**	**558 (100)**

Values in the same row not sharing the same subscript are significantly different at $p < 0.05$.
[a] The percentage value of the total sample size within the same column.

The growing awareness about COVID-19, with vaccines made available to the public, has likely reduced the anxieties of more than half of the respondents (55%). The current results are consistent with those of Raciborski, Jankowski, Gujski, Pinkas, and Samel-Kowalik (2021), who reported that public concerns about COVID-19 infection in Poland substantially decreased one year after the authorities declared COVID-19 a pandemic.

Furthermore, in comparison with the previous year, a significantly higher proportion of Tunisians reported being still concerned (34%) and even more concerned (28%) about COVID-19 risk compared to the Jordanians, 21% and 7%, and Lebanese, 25% and 9%, respectively. This difference might be due to the rapid increase of COVID-19 in Tunisia triggered by the Delta coronavirus variant in July 2021, resulting in the healthcare system's dramatic and critical collapse (Africa CDC, 2021). In addition, Tunisia recorded the highest coronavirus mortality rate in the Middle East region and Africa. The number of deaths almost doubled in less than a week (from 5th to 8th July) from 119 to 189 deaths (WHO, 2021). According to Amnesty International Public Statement (2021), the Tunisian government announced their national vaccination programme in January 2021 and started implementing it in March 2021 through an online platform, EVAX. However, the strategy was undermined by a lack of transparency around the criteria to include certain professions as essential services, undue political interference in the roll-out, and significant delays in vaccination due to the global shortage of vaccines and the government's political instability (Amnesty, 2021). These were all factors affecting public trust and anxiety levels and explaining the considerable lag in numbers of vaccinated respondents.

Data analysis also showed that 66% of vaccinated Jordanian, 64% of vaccinated Lebanese, and only 33% of vaccinated Tunisian participants were no longer concerned or less concerned about COVID-19 risks compared to the previous year. The trust in the vaccine's efficacy in reducing COVID-19 symptoms and complications varied significantly between Tunisia (47%) and both Lebanon (71%) and Jordan (62%) ($p < 0.05$) (Table 3). For instance, significantly more Tunisians (53%) than Lebanese (29%) and Jordanians (38%) were unsure or disagreed with the vaccines' benefits (Table 3). The difference in people's perception of health risks and vaccination uptake could be attributed to the varying levels of trust in the vaccination benefits.

Regression analysis showed that the Jordanian group was 1.8 times (Odds ratio = 1.848, 95% CI = 1.208–2.826, $p = 0.005$) and the Lebanese were 2.7 times (Odds ratio = 2.723, 95% CI = 1.758–4.217, $p < 0.001$) more likely to trust that the vaccine protects them against COVID-19 infection or symptoms compared to the Tunisian group. In contrast, a previous small-scale qualitative study in Tunisia reported that all participants were sure about the efficacy and safety of the vaccines (Rabaa et al., 2021); however, due to its small sample size, i.e., a focus group of 11 randomly selected people, this study's outcomes may

Table 3
Public trust in the vaccination benefits for health and safety of food handled by vaccinated food workers.

		Country of residence			
		Jordan N (%)[a]	Tunisia N (%)[a]	Lebanon N (%)[a]	Grand Total
Vaccination protects against COVID-19 by reducing symptoms and infections	No/I don't know	76 (38)$_a$	82 (53)$_b$	59(29)$_a$	**217 (39)**
	Yes	125 (62)$_a$	73 (47)$_b$	143 (71)$_a$	**341 (61)**
	Grand Total	**201 (36)**	**155 (28)**	**202 (36)**	558 (100)
I trust eating food prepared by vaccinated food handlers	No/I don't know	97 (48)$_a$	100 (65)$_b$	100 (50)$_a$	**297 (53)**
	Yes	104 (52)$_a$	55 (35)$_b$	102 (51)$_a$	**261 (47)**
	Grand Total	**201 (36)**	**155 (28)**	**202 (36)**	**558 (100)**

Values in the same row not sharing the same subscript are significantly different at $p < 0.05$.
[a] The percentage value of the total sample size within the same column.

not accurately reflect the general trends of the Tunisian population or compare with the current results.

The latter aligns with El-Elimat et al. (2021), who reported a high level of trust in Jordan in the safety and effectiveness of vaccines in protecting against COVID-19 infection. Similarly, 63% of the surveyed subjects in the United Arab Emirates trusted the safety and efficacy of the COVID-19 vaccine (Muqattash et al., 2020). Also, about 52% of Malaysians agreed that vaccination would protect them from getting infected (Mohamed et al., 2021). However, vaccinated people may feel that they are entirely immunized and could adhere less to the precautionary measures to prevent virus transmission, such as hand-cleansing, wearing masks, physical distancing, and limiting contact with others (Wright et al., 2022). Andersson et al. (2021) also substantiated that anticipation of vaccines impacted peoples' concerns and willingness to follow safety measures towards COVID-19 as they think of the potential end of the pandemic.

Nevertheless, lower concern levels were particularly reported among unvaccinated participants in Jordan (71%) compared to 46% and 36% in Lebanon and Tunisia, respectively. These reduced worries are possibly related to a common belief observed among the Jordanians that living within a vaccinated community would shield and protect unvaccinated persons from the virus. The Pearson Chi-Square test further confirmed a statistically insignificant association between public concerns about COVID-19 health risks and the vaccination level, as the significance level approached 0.05, i.e., ($\chi(1) = 3.832$, $p = 0.05$). Additionally, The Chi-Square test performed at the country level showed no link between concerns of COVID-19 health risks and whether the respondents were vaccinated or not in the three countries ($p > 0.05$). For instance, both vaccinated and unvaccinated surveyed subjects in Tunisia reported similar levels of concerns about the health risk of COVID-19.

The extent to which people might be worried about COVID-19 health risks is influenced by a myriad of other factors than the efficacy of the vaccines, such as an individual's health, socio-economic effects and social vulnerability. For instance, more than half of the surveyed subjects (57%) had themselves or at least a member of their families contracted COVID-19 before vaccination. Of those, around two-thirds (62%) were vaccinated with anxiety about the disease observed in more than a third (40%). Cerda and García (2021) maintained that those immunocompromised, or who have a chronic illness, or a family member infected with COVID-19 would likely still be more concerned about being infected. In a similar vein, Saddik et al. (2021) reported a higher willingness and stronger intention to take the COVID-19 vaccine among people with significant concerns and anxieties.

3.2. Perception of food safety risks affected by trust in the vaccination benefits

Overall, only 33% of the participants were not concerned about getting COVID-19 through food (Fig. 2), with less than half of the participants (40%) in Lebanon reported no concerns about getting infected from food and a comparable proportion in the Jordanian group (37%). In contrast, most respondents in Tunisia (81%) were worried about COVID-19 transmission from food (Fig. 2). Furthermore, less than half of the surveyed subjects (47%) trusted eating food prepared by vaccinated food handlers (Table 3) which aligns with the increased perception of food safety risks during the pandemic (Fig. 2). The public concerns about food-related risks of infection were expected to have eased down or show less reported frequencies, considering people's awareness of the risks gained over time. However, despite the local and global health authorities' claims that there is no evidence food transmits COVID-19, the public still fears contracting the disease from food. These results indicate a tendency to stigmatize food in the pandemics. Hao and Wang (2021) showed in the case study on Wuhan hot instant noodles that food stigma is not easy to eradicate and can burden the economy. Although Wuhan hot instant noodles can be produced elsewhere, they were avoided by consumers given its name that signifies Wuhan, the pandemic's epicentre; such invalid worries can have economic and health implications on societies. The current authors' previous work showed that 70% of the respondents considered COVID-19 a foodborne disease (Faour-Klingbeil et al., 2021a). Consequently, people's worries about contracting the disease through contaminated food have led to a significant reduction in their consumption of ready-to-eat food (RTE) and ordering hot and cold RTE food deliveries and overuse of cleaning agents, including soaps non-food grade chlorine bleach for washing fresh fruits and vegetables (Faour-Klingbeil et al., 2021b), also to the public' engagement in risky practices (Gharpure, 2020).

Kruskal Wallis test showed significant differences between Jordan and Tunisia ($p = 0.024$), and Tunisia and Lebanon ($p = 0.03$) (Table 5). The Jordanians (Odds ratio = 1.949, 95% CI = 1.268–2.996, $p = 0.002$) and Lebanese (Odds ratio = 1.855, 95% CI = 1.207–2.849, $p = 0.005$) were more likely to trust eating food prepared by vaccinated food handlers than the Tunisians. Trust in vaccines may change food-related behaviors among both food workers and consumers. At the same time, people seem to be more reassured when knowing that workers in restaurants are vaccinated. For instance, the United States Food and Drug Administration (FDA) encouraged food workers to take the vaccines as they are at increased risk of infection; such reasons for vulnerability are due to being in contact with coworkers in closed working places and with community customers (US FDA, 2021). The restaurant industry also advertised a fully vaccinated workforce to attract customers to trust and eat at their restaurants (The National Review, 2021). Same in

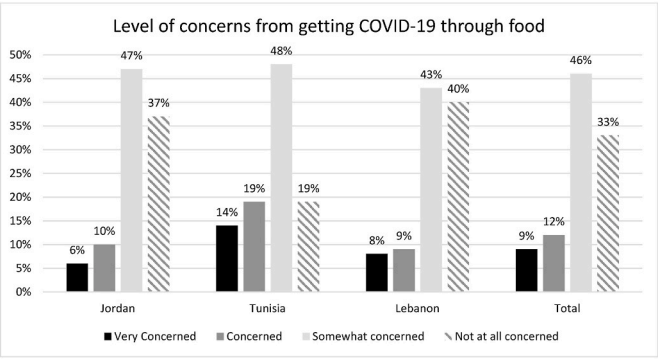

Fig. 2. The percentage distribution of level of concerns about contracting COVID-19 from food.

Jordan, vaccination of workers in the food industry has been promoted and later mandated for issuing or renewing work permits for employees in bakeries, cafes and restaurants (Jordan Times, 2021).

Furthermore, in the interest of exploring the influence of vaccination on public perception of food safety during the pandemic, the regression analysis showed that vaccinated participants tend to have 2.54 times more trust in eating food prepared by vaccinated food handlers than unvaccinated participants (Odds ratio = 2.549, 95% CI = 1.771–3.669, $p < 0.001$). Additionally, binomial regression ascertained the effect of the vaccination on the public perception of food safety risks. A significant improvement in fit of the final model over the null model was obtained ($\chi^2(1) = 5.185$, $p = 0.023$), suggesting that vaccination is a significant predictor of public concerns about getting COVID-19 infection from food. The model explained that being vaccinated was 0.65 times less likely to be worried about getting COVID-19 infection from food than when not vaccinated.

Moreover, participants worried about getting COVID-19 from food were 0.419 times less likely to trust eating food outside the home prepared by vaccinated food handlers (Odds ratio = 0.419, 95% CI = 0.292–0.601, $p < 0.001$). The excessive worries of the Tunisians about contracting COVID-19 from food and their lack of trust in eating food handled by vaccinated food handlers compared to Lebanese and Jordanians is a case in point. The disbelief in the vaccination's health benefits and the substantially low proportion of vaccinated subjects among the Tunisians contributed to more worries and higher risks perception than their counterparts. While the findings substantiated that vaccination affects how people perceive food safety and their food decision, an association was not found with their concerns about the health risks of COVID-19. Whether vaccinated or not, people are likely to be still wary of the recurrent waves of infections because of the adverse health effects of the disease; add to this, the vaccines are reportedly not 100% effective, and cases of re-infected vaccinated people are constantly recorded (CDC, 2020).

3.3. Changes in food consumption, hygiene practices and protective measures relative to the previous year

Overall, the proportion of respondents who maintained or increased hygiene measures was higher than those who reduced or abandoned these habits. The results showed that in comparison with the previous year, a higher proportion of respondents (36%) had increased the frequency of disposing of and/or disinfecting food packages before storing them at home than those reporting a reduced frequency (22%) (Table 4). However, a remarkably higher number of respondents increased the frequency of handwashing and sanitizing after touching food packages (65%) and returning home (68%) compared to only 10% and 13% who reported a reduced frequency compared to the previous year, for both occasions, respectively (Table 4). Hand hygiene is now a fundamental requirement enforced almost everywhere and in every sector, in businesses and public places. The public health emphasis on hand hygiene as the frontline defense against the disease was and is still widespread. Broadcasting and print media, social media, flyers and posters in public, commercial, and private settings, and other sources have probably sparked positive behavioural changes through targeted promotional campaigns on the importance of hand hygiene to stop the spread of the virus. Those who thought themselves at a higher risk of contracting SARS-CoV-2 perceived handwashing as an effective preventive measure and were more likely to engage in hand hygiene practice more frequently during the pandemic (Dwipayanti et al., 2021). In China, around 63% of respondents stated they washed their hands more regularly since when the outbreak began; also, in Indonesia, 82.3% of female respondents and 73.4% of male respondents reported handwashing practice eight times or more per day during the COVID-19 pandemic (Dwipayanti et al., 2021).

Several public health initiatives in the studied countries have also emphasized handwashing practices to curb the pandemic (ENI-CBC,

Table 4
Changes in the frequency level of the hygiene practices and protective measures compared to the previous year.

Statement on behavioral changes	Frequency level[a]	Country of residence			
		Jordan	Tunisia	Lebanon	Grand Total
		N (%)[b]	N (%)[b]	N (%)[b]	N (%)[c]
Discarding food packages before storing food at home	Never followed the practice	21 (10)	33 (21)	31 (15)	85 (15)
	Less frequent	45 (23)	33 (21)	43 (21)	121 (22)
	The same	68 (34)	37 (24)	46 (23)	151 (27)
	More frequent	67 (33)	52 (34)	82 (41)	201 (36)
	Grand Total	**201 (36)**	**155 (28)**	**202 (36)**	**558 (100)**
Disinfecting packaged food before storing at home	Never followed the practice	13 (6)	25 (16)	18 (9)	56 (10)
	Less frequent	52 (26)	44 (28)	41 (20)	137 (25)
	The same	52 (26)	26 (17)	36 (18)	114 (20)
	More frequent	84 (42)	60 (39)	107 (53)	251 (45)
	Grand Total	**201 (36)**	**155 (28)**	**202 (36)**	**558 (100)**
Washing and sanitizing my hands after touching delivery bags or food packages	Never followed the practice	3 (2)	9 (6)	3 (1)	15 (3)
	Less frequent	22 (11)	21 (14)	14 (7)	57 (10)
	The same	41 (20)	25 (16)	58 (29)	124 (22)
	More frequent	135 (67)	100 (64)	127 (63)	362 (65)
	Grand Total	**201 (36)**	**155 (28)**	**202 (36)**	**558 (100)**
Washing and/or sanitizing my hands when returning home	Never followed this practice	5 (3)	5 (3)	3 (2)	13 (2)
	Less frequent	22 (11)	24 (16)	23 (11)	69 (13)
	The same	29 (14)	25 (16)	43 (21)	97 (17)
	More frequent	145 (72)	101 (65)	133 (66)	379 (68)
	Grand Total	**201 (36)**	**155 (28)**	**202 (36)**	**558 (100)**
Placing delivery orders for hot ready-to-eat food	Never followed this practice	30 (15)	86 (56)	53 (26)	169 (30)
	Less frequent	51 (25)	35 (22)	81 (40)	167 (30)
	The same	81 (40)	20 (13)	50 (25)	151 (27)
	More frequent	39 (20)	14 (9)	18 (9)	71 (13)
	Grand Total	**201 (36)**	**155 (28)**	**202 (36)**	**558 (100)**
Placing delivery orders for cold ready-to-eat food	Never followed this practice	55 (27)	98 (63)	85 (42)	238 (43)
	Less frequent	50 (25)	27 (17)	67 (33)	144 (26)
	The same	71 (35)	20 (13)	36 (18)	127 (23)
	More frequent	25 (13)	10 (7)	14 (7)	49 (8)
	Grand Total	**201 (36)**	**155 (28)**	**202 (36)**	**558 (100)**
Placing delivery orders for groceries	Never followed this practice	66 (33)	93 (60)	46 (23)	205 (37)

(*continued on next page*)

Table 4 (*continued*)

Statement on behavioral changes	Frequency level[a]	Country of residence			
		Jordan	Tunisia	Lebanon	Grand Total
		N (%)[b]	N (%)[b]	N (%)[b]	N (%)[c]
	Less frequent	35 (17)	30 (19)	47 (23)	112 (20)
	The same	58 (29)	22 (14)	64 (32)	144 (26)
	More frequent	42 (21)	10 (7)	45 (22)	97 (17)
	Grand Total	**201 (36)**	**155 (28)**	**202 (36)**	**558 (100)**

[a] Changes in frequency levels when compared to the year preceding this survey.
[b] % of the total respondents in each country.
[c] % of the total sample size N of the three countries.

2020; OCHA, 2020). When compared to pre-COVID-19 times, the current authors' previous work showed that extreme worries of contracting the disease via touching food packages led to more than 32% and 24% increase in handwashing practices during the pandemic after touching food packages and bags and returning home, respectively, in Lebanon, Jordan, and Tunisia. Additionally, the disposal of the ready-to-eat (RTE) food shopping bags and food boxes and packages in the garbage has risen by 22–23% (Faour-Klingbeil et al., 2021b).

For almost a third (30%) of the surveyed subjects, the RTE food consumption decreased in frequency while not changing for 27%. In contrast, only 13% of the respondents reported buying RTE foods more frequently than the previous year. Nevertheless, a higher proportion of the Lebanese respondents (40%) than Jordanians (25%) and Tunisians (22%) ate less RTE foods during the pandemic ($p < 0.001$), likely due to food safety-related reasons but also the reduced purchasing power for food commodities given the ongoing financial and economic crisis in Lebanon (WFP, 2021). The reduced trend in RTE consumption indicates persisting concerns about contracting COVID-19, as observed in the initial phase of the pandemic (Faour-Klingbeil et al., 2021a).

On the other hand, there has not been a sharp change in the frequency levels of placing grocery orders compared to the previous year. Less than a third, 26% and 20% of surveyed subjects, reported maintaining the same or reducing the order frequencies, respectively, compared to 17% who relied much more than the previous year on delivered groceries. In addition, there was a significant difference between the Tunisian survey participants group and the Lebanese and Jordanians ones ($p < 0.001$); sixty percent of Tunisian participants never ordered groceries, whereas 21% and 22% of Jordanian and Lebanese respondents placed grocery delivery orders much more frequently than the previous year, respectively.

3.4. The clarity of information obtained from the local authorities on the vaccination

Overall, 51% of the surveyed subjects rated the clarity of information obtained from local authorities on COVID-19 vaccination as good to excellent, whereas 18% believed it was weak (Table 5). At a country level, the clarity of information on vaccination was perceived as good to excellent by more than half of the respondents in Jordan (67%) and Lebanon (63%), compared to only 16% in Tunisia (Table 5). Furthermore, one-way ANOVA showed a significant difference between the countries; for instance, on a scale of 3 = excellent/good to 1 = weak, Tukey post hoc test revealed that the information obtained from local authorities was significantly more satisfactory for the Jordanian (2.51 ± 0.70) and Lebanese groups (2.51 ± 0.70) compared to the Tunisians (1.79 ± 0.70), ($p < 0.001$). In general, the Tunisians were four times more than the Lebanese and Jordanians dissatisfied, rating the information on the vaccines as weak. Yet, more than a third of the Lebanese and Jordanians did not perceive the information as adequate.

Table 5
Public opinions on the clarity of information on the vaccination.

Clarity of information obtained from the local authorities on vaccination	Country of residence			
	Jordan N (%)	Tunisia N (%)	Lebanon N (%)	Grand Total
Excellent/good	134 (67)	25 (16)	128 (63)	287 (51)
Average	50 (25)	73 (47)	50 (25)	173 (31)
Weak	17 (8)	57 (37)	24 (12)	98 (18)
Grand Total	**201 (36)**	**155 (28)**	**202 (36)**	**558 (100)**

These results corroborate the findings of the authors' previous study, which showed that Tunisians were less satisfied than the Jordanians and Lebanese with the role of their local authorities in the fast dissemination of information, intervening to protect the public, and sharing of scientific information in an easy-to-understand way (Faour-Klingbeil et al., 2021a). Together with the results on public trust in the vaccination benefits (Table 3), the data suggest an ongoing lack of an effective communication strategy needed to instil confidence and boost trust in the vaccination's effectiveness.

3.5. Public trust in local authorities' performance during the pandemic compared to the previous year

The public trust in the local authorities' risk management during the pandemic had not shown a remarkable change since before this survey was conducted for 25%, 21%, and 26% of the surveyed subjects in Jordan, Tunisia and Lebanon, respectively (Fig. 3). However, a greater proportion of the surveyed Lebanese (45%) reported they still did not trust their local health authorities, and 35% and 33% in Tunisia and Jordan have lost trust over the last year, respectively. Moreover, only a low proportion of participants in Jordan (15%), Tunisia (9%) and Lebanon (14%) reported gaining more trust compared to the previous year.

The statistical analysis showed that respondents from Jordan and Tunisia had comparable trust in how local authorities managed the risks during the pandemic ($p = 0.371$). At the same time, there were significant differences between both Jordan and Lebanon ($p < 0.001$), and Tunisia and Lebanon ($p = 0.001$). For instance, the Lebanese respondents tended to have a stronger distrust than their counterparts, likely attributed to the government's current political and economic failures. The Lebanese healthcare stakeholders expressed concerns about the politicization of vaccines in the absence of open and

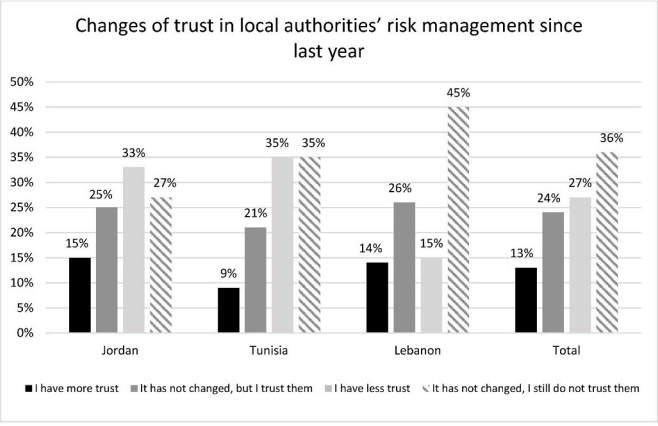

Fig. 3. Changes in trust in local authorities' risk management since the year before this survey.

transparent communication on the vaccination process and strategy to access the vaccines, given the dire economic crises. In this case, politically-connected individuals, communities or political parties may access the vaccines before the most vulnerable and financially affected populations (Abi-Rached & Salameh, 2021). In addition, the vaccination plan in Lebanon was slow, and public health measures were practically nonexistent (El Murr, 2021). For example, the COVID-19 vaccine committee's strategy for procurement and roll-out was reportedly unsustainable, and the pandemic containment rules and testing-and-tracing regulations at the airport were not implemented. Furthermore, actions were not taken with the reopening of crowded public spaces to ensure necessary preventive measures, such as masks and social distancing, to avoid or limit a new surge of infections, hospitalizations, and deaths (El Murr, 2021).

In Tunisia, a serious erosion of public trust also resulted from political interference, which affected the national vaccination efforts and pandemic control (Amnesty, 2021). Tunisia has changed health ministers four times since the start of the pandemic. It is locked in a political standoff between the head of the government and the president of the republic, which reportedly delayed the pre-order of vaccines. On the other hand, the increased level of public trust in the Jordanian local authorities at the beginning of the pandemic is related to promptly adopted measures by the government through a collaborative multi-disciplinary team at the highest levels at the National Center for Security and Crises Management (NCSCM) (Africa CDC, 2021). During the first months of the pandemic, the lockdown allowed the health authorities to delay the onset of the first wave of the pandemic till September 2020 and provide a better quality of diagnosis and medical treatment (Africa CDC, 2021). In addition, the government afforded some -but insufficient- socio-economic support to targeted people, and the health authorities continued providing support such as the four types of vaccines to all people in Jordan. However, after a year of restricted measures and obligatory vaccination, many people experienced some hardships, and their level of trust in local authorities has also declined (El-Elimat et al., 2021).

The trust level in the government's management of the COVID-19 pandemic varies worldwide. While Edelman (2020) showed a double-digit increase in public trust (Edelman Trust Barometer, 2020), many people in the U.S. reported that the handling of the COVID-19 pandemic was substandard, and their trust in the government has been eroded (Deslatte, 2020). The perceived performance in terms of effective policies and instructions applied in managing COVID-19 pandemic reflects the public trust in their governments. For instance, 80% of Australians and 83% of New Zealanders agreed that governments were generally trustworthy, and the performance in the pandemic management had increased their trust in the government (Goldfinch et al., 2021). COVID-19 could be a chance for local authorities to rebuild and regain public trust (Pak et al., 2021). Therefore, to maintain continued trust, measures taken by governments must meet and fulfil people's expectations (Liu et al., 2014).

3.6. The primary and most minor concerns during the pandemic

In the current study, four other concerns were examined during the pandemic besides food safety, i.e., economic constraint, social distance, lack of clarity about the pandemic and shortage of food supply. Interestingly, the results showed that concerns about food safety and shortage of food supply did not measure up to other sources of concerns, such as economic constraints, which were the primary concern during the pandemic for 56% of surveyed subjects in the current study, followed by the lack of clarity about the disease (Fig. 4). While initiatives of the food sector and local communities in ensuring a supply of essential food products under hygiene measures were ongoing during the pandemic and lockdown (IBC-SP, 2020), the socio-economic support programs were scant in the studied countries compared to USA and E.U. countries. Relative to food-related issues, the economic effects of

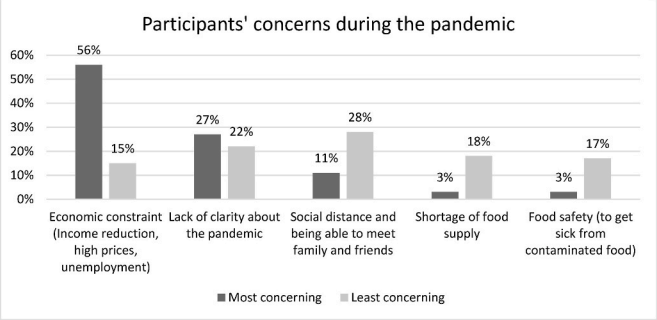

Fig. 4. The primary and most minor concerns during the pandemic.

COVID-19 have been reported on a global scale, and populations concerns can be read from the economic literature. For instance, results of the OECD report (2020) found that the strict measures taken by the governments in Jordan, Lebanon, and Tunisia have forced employers to close or reduce their businesses and lay off staff and lower salaries. As a result, enterprises across all sectors and people from different groups, especially youth and women, were negatively impacted, resulting in an increased rate of unemployment and poverty (OECD, 2020).

On the other hand, some considered social distancing an irritating issue during the pandemic. Although social distancing measures are an essential strategy for controlling the spread of the virus (Hwang et al., 2020), social distancing is considered a stressful event on a personal level and cause many people to feel isolated and anxious about social disconnection (Hwang et al., 2020).

There were no statistically significant differences between participants' opinions from Jordan, Tunisia and Lebanon ($p > 0.05$) on their primary concerns during the pandemic. For instance, the primary concern was the economic constraint for more than half of the respondents in Jordan (59%), Tunisia (52%) and Lebanon (57%) (Fig. 5). However, the minor concerns differed significantly between the countries ($p = 0.022$). Concerns from social distance were reported in Jordan and Tunisia, 32% and 27%, respectively (Fig. 6). High vaccination rates followed by a relaxation of social restrictions in Jordan and Tunisia may explain the respondents' reduced concerns about the social distance one year after the pandemic (MEED, 2021). In Lebanon, the stream of COVID-19 misinformation delivered to the Lebanese along with the population distrustful of government (as mentioned in section 3.5) and the economic distress ranks the lack of clarity about the pandemic as a minor concern (27%) (Fig. 6).

4. Limitation of the study

One limitation of this study is that the online recruited sample is non-representative of the population and largely educated. While the outcomes can not be generalized or their meaning amplified, the data

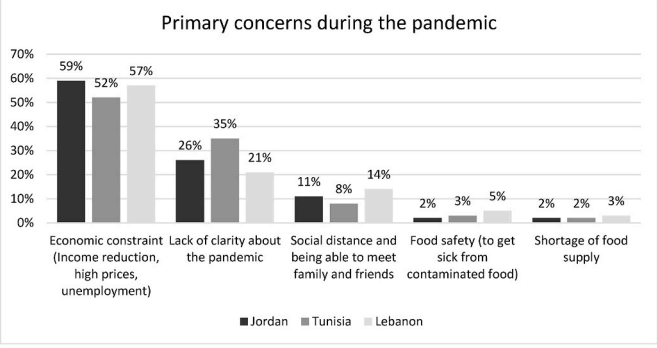

Fig. 5. The primary concerns during the pandemic by country.

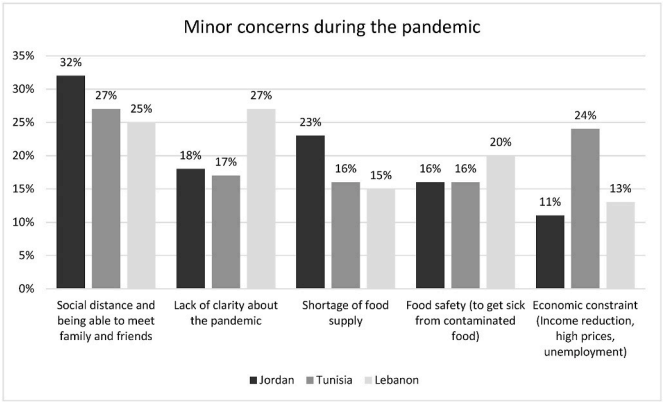

Fig. 6. The minor concerns during the pandemic by country.

provide new findings and insight into existing issues that might be rooted elsewhere in the communities of the studied countries and not covered in this study.

In addition, this survey preceded the Omicron variant wave, which has revealed conflicting management approaches in different countries and augmented public resistance to continued restrictions, keeping some questions open for additional research. How long the public will maintain a rigorous hand hygiene regimen after the pandemic is over and being sceptical of governmental health-related policies remains to be seen.

5. Conclusion

This study substantiated that the worries of getting COVID-19 from food are persistent for a fraction of the studied sample and that vaccination policy positively affects the public perception of food-related risks. The current findings provided evidence of the tendency of food stigma during the pandemic, which might strain the economy of food businesses. In addition, the frequency of handwashing had notably risen, besides the increased hygiene measures related to disinfecting food packages. The heightened adherence to hygiene measures implies that the recurrent waves of the pandemic and the direct or indirect experience of people with the disease's adverse health effects have contributed to the expanded concerns about COVID-19 infections.

One year after the pandemic, local health authorities of the studied countries still have not met the expectations of the surveyed population. A significant proportion of the study sample, predominantly the Tunisians, had lost trust in their local health authorities' pandemic management and was more dissatisfied with the information obtained on the vaccines than those who reported more trust.

Hence, to trust that food is not a vehicle of COVID-19 infections and the vaccine's benefits, the government's role is instrumental in garnering public trust through open and transparent exchange with the stakeholder. Public health communications are vital to informing the public on managing risks and preventing transmission during pandemics, including vaccination acceptance and uptake. Nevertheless, meeting the public's expectations and enhancing awareness require psychological interventions and developing targeted communications to convey scientific information. The handwashing campaigns are a case in point as they have successfully instilled positive changes in people's hygiene behaviour through unprecedented engagements of governments, local and international organizations, and local communities. Initiatives targeted to wane invalid fears would need to rely on an equally intensive campaign of the magnitude of hand hygiene messages.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of interest

None.

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. **Asma' O.Taybeh:** Formal analysis, Writing – review & editing. **Monia Jemni:** Investigation, Writing – original draft. **Ewen C.D. Todd:** Conceptualization, Writing – review & editing.

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