THE EFFECTS OF THE COVID-19 OUTBREAK ON FOOD SUPPLY, DIETARY PATTERNS, NUTRITION AND HEALTH: VOLUME 2

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THE EFFECTS OF THE COVID-19 OUTBREAK ON FOOD SUPPLY, DIETARY PATTERNS, NUTRITION AND HEALTH: VOLUME 2

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Negative Impacts of COVID-19 Induced Lockdown on Changes in Eating Behavior, Physical Activity, and Mental Health as Modified by Digital Healthy Diet Literacy and eHealth Literacy

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Background: The COVID-19-induced lockdown has been implemented in many countries, which may cause unfavorable changes in lifestyles and psychological health. People's health literacy, healthy diet, and lifestyles play important roles in mitigating the negative impacts of the pandemic. Therefore, we aimed to examine associations of COVID-19 lockdown with changes in eating behavior, physical activity, and mental health; and the modification effects by digital healthy diet literacy (DDL) and eHealth literacy (eHEALS) on the associations.

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Methods: We conducted an observational study on 4,348 outpatients from 7th April to 31st May 2020. Data from 11 hospitals in Vietnam included demographic characteristics, DDL, eHEALS, eating behavior, physical activity, and mental health changes. Multiple logistic regression and interaction models were performed to examine associations.

Results: Patients under lockdown had a lower likelihood of having "unchanged or healthier" eating behavior (odds ratio, OR, 0.38; 95% confidence interval, 95%CI, 0.29 to 0.51; $p < 0.001$), "unchanged or more" physical activity (OR, 0.79; 95% CI, 0.69 to 0.90; $p < 0.001$), and "stable or better" mental health (OR, 0.77; 95% CI, 0.67 to 0.89; $p < 0.001$), as compared to those after lockdown. In interaction models, as compared to patients after lockdown and with the lowest DDL score, those under lockdown and with a one-score increment of DDL had a higher likelihood of having "unchanged or healthier" eating behavior (OR, 1.05; 95% CI, 1.02 to 1.07; $p < 0.001$), and "stable or better" mental health (OR, 1.02; 95% CI, 1.01 to 1.04; $p < 0.001$). Similarly, as compared to patients after lockdown and with the lowest eHEALS score, those under lockdown and with a one-score increment of eHEALS had a higher likelihood of having an "unchanged or more" physical activity (OR, 1.03; 95% CI, 1.01 to 1.05; $p < 0.001$).

Conclusion: The COVID-19 lockdown measure could negatively affect eating behavior, physical activity, and mental health among outpatients. Better DDL and eHEALS were found to mitigate the negative impacts of the lockdown, which may empower outpatients to maintain healthy lifestyles and protect mental health. However, this study holds several limitations that may undermine the certainty of reported findings.

Keywords: lockdown, mental health, digital healthy diet literacy, eHealth literacy, eating behavior, outpatient, physical activity

INTRODUCTION

New waves of COVID-19 outbreaks continuously re-emerged in many countries around the world (1, 2). Although vaccination programs have been deployed globally, the disproportionate distribution of vaccines (3, 4) and the emergence of new COVID-19 variants make the pandemic still uncontrolled (5, 6). Affected countries have been applying strict prevention measures such as lockdown, home confinement, and social distancing (7). Although these measures have effectively prevented the spread of the virus, it causes significant changes in people's lives, including working from home and lack of connection with family and friends (8, 9). In addition, lockdown or home confinement measures make people feel bored and isolated, negatively affecting their psychological health (10, 11). These adverse impacts on mental health can cause harmful lifestyle changes such as increasing unhealthy eating habits (12–15), sedentary behavior, or sleeping disorders (16). Recent literature also indicated that the isolation and COVID-19 lockdown had negative impacts on eating habits and emotional processing (17, 18). Furthermore, movement restrictions and difficulty accessing fresh food during the lockdown period could significantly affect people's eating patterns and physical activity habits (19–25). Therefore, it is urgent to assess the impacts of COVID-19 lockdown on changes in eating behavior, physical activity, and mental health and find protective factors that could mitigate such impacts.

The advent of the Internet and the advancement of smartphones and computer technology make it easier for people to access health information (26, 27). People could use and access web-based resources at any time to seek health advice, disease information, and check physician's consultation (28, 29). However, accessing health information and support through the Internet also has potential risks. With the ease of delivering health information through social networks and websites, it is difficult for people to recognize and evaluate which information is high-quality and reliable (30). Notably, the COVID-19 pandemic has caused an "infodemic" with a plethora of false and fake news about the disease (31, 32). This information could lead to worry and fear in the community, distrust in the government's epidemic containment efforts, and wrong health decisions (33–35). Therefore, improving skills to find, evaluate, and understand health information on the Internet is essential, especially during the COVID-19 lockdowns.

Digital healthy diet literacy (DDL) and eHealth literacy (eHEALS) have potential impacts in improving healthy lifestyles and general health during the pandemic. DDL is the ability to find, understand, evaluate, and apply healthy eating information from web-based sources to improve the eating behaviors" (36). Meanwhile, eHEALS is defined as the capacity to seek, understand, and appraise online health information and apply it

to solve health issues (37). Recent literature showed that DDL was found to be associated with a higher likelihood of healthier eating, better mental health, and quality of life during the pandemic (36, 38, 39). Meanwhile, people with higher eHEALS were more likely to have better psychological health, engage in positive health-related behaviors (e.g., healthy eating, physical activity) (40–43). In addition, previous research also indicated that DDL and eHEALS could help to mitigate the negative impacts of COVID-19 on quality of life among outpatients (39). Therefore, DDL and eHEALS roles should be investigated and paid more attention to in the lockdown period.

During the pandemic, people seeking medical care have faced many challenges, such as limited access to medical care, delays in treatment, fear of COVID-19 infection, and worry about their health (35, 44, 45). As a result, maintaining healthy lifestyles and stabilizing mental health is essential to improve their health and overcome difficulties, especially in the lockdown period (46). Therefore, we conducted this study to examine the associations of COVID-19 induced lockdown with changes in eating behavior, physical activity, and mental health; and further determine whether DDL and eHEALS could modify these associations among outpatients from 11 hospitals across Vietnam.

MATERIALS AND METHODS

Study Design, Settings, and Sampling

A cross-sectional survey was conducted in outpatients from eleven hospitals across Vietnam. Participants were recruited at selected hospitals using the convenience sampling method from 7th April to 31st May 2020. The Vietnamese Government announced a nationwide lockdown from 1 to 22 April to contain the spread of the COVID-19 pandemic (47, 48). During the lockdown period, all people are ordered not to leave their homes except for emergency cases, buying essential goods or medicine, and are prohibited from gathering more than two people in public. If going outside, people must wear a mask and keep a safe distance of two meters from others. The stringent social distancing and isolation measures yielded positive results, and no confirmed COVID-19 cases were recorded in Vietnam from mid-April to the end of May 2020 (49). After 22 April 2020, Vietnam began to gradually lift strict movement restrictions, including allowing businesses activities and schools in many parts of Viet Nam to re-open, and resuming domestic travel across the country. However, epidemic prevention measures continued to be implemented according to the "5K Rule" of the Vietnam Ministry of Health, including wearing a mask when going out, washing hands regularly with soap or sanitizer, keeping a safe distance from others, not gathering in crowds, and making a medical declaration (50).

Due to a convenience sample, we aimed to recruit as many participants as possible to reduce the sampling bias and increase the representativeness of the sample. Inclusion criteria were those who visited the outpatient department (OPD) of studied hospitals at the time of this study, aged 18–85, without emergency conditions (e.g., stroke, traumatic brain injury, etc.), and who agreed to participate in the survey. In addition, we excluded patients who had communication difficulties (e.g., deafness or blindness). Finally, we collected and analyzed the data of 4,348 participants. **Figure 1** showed the number of patients at each hospital participating in this study (39).

This study was approved by the Ethics Committee of Hanoi University of Public Health (IRB Number: 133/2020/YTCC-HD3).

Data Collection Procedure

At OPDs of studied hospitals, research assistants (physicians, nurses, and healthcare students) informed patients about the purposes of this study and invited them to participate in the investigation. Informed consent forms were signed before participants carried out the survey. Data was obtained through structured self-administered questionnaires. During the waiting time for examination, participants could take the survey using their smartphone to fill out the online questionnaire via QR code or the printed ones provided at OPDs. The online and printed versions of the questionnaire have the same structure and code. Throughout the time of the survey, research assistants supervised and assisted participants in completing the investigation. Printed questionnaires were checked as participants completed to ensure that all questions were answered. There was no missing data for the online version as all questions included the forced answering option. Therefore, the missing data in this study were minimal. We used the pair-wise deletion method to handle missing data. It took around 10–15 min for each survey. The patient's data was then coded and analyzed for study purposes only.

Assessments and Measurements

Participant's Characteristics

Demographic characteristics were obtained regarding age, gender, marital status (never married vs. ever married), education levels (junior high school or lower vs. senior high school vs. college/university or higher), occupational status (no job vs. has a job), ability to pay for medical care (easy vs. difficult), social status (low vs. middle or high). We calculated body mass index (BMI, kg/m^2) based on self-reported body weight (kg) and height (cm) and then categorized into three groups: underweight (BMI $<$ 18.5), normal weight (18.5 $\leq$ BMI $<$ 25.0), and overweight/obese (BMI $\geq$ 25.0). The questionnaire used the 14 items of the Charlson Comorbidity Index (51) to assess patients' comorbidities. We then categorized the comorbidity into two groups: "none" vs. "one or more" diseases. Participants with any symptoms resembling COVID-19 (Slike-CV19S), including fever, cough, dyspnea, myalgia, fatigue, sputum production, confusion, headache, sore throat, rhinorrhea, chest pain, hemoptysis, diarrhea, and vomiting (52), were classified as having Slike-CV19S.

COVID-19 Induced Lockdown

The national lockdown measure was implemented in Vietnam from April 1–22, 2020 (47, 48). The execution time was categorized into two groups: "under lockdown" vs. "after lockdown," where patients who conducted the survey in the lockdown period were classified as those under lockdown.

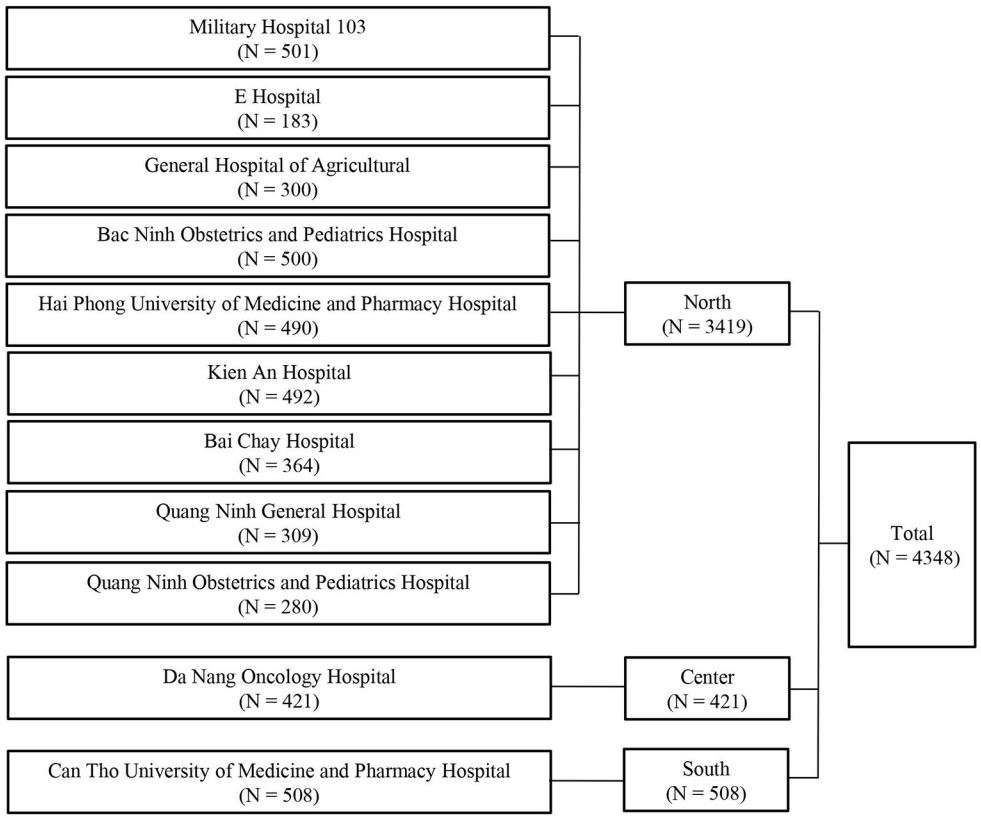

FIGURE 1 | Flow chart of the study sample.

Changes in Eating Behavior, Physical Activity, and Mental Health

The questionnaire asked participants about the changes in their current eating and physical activity behaviors compared to those before the COVID-19 pandemic. Patients responded on a five-point scale (never, stopped, less active, unchanged, and more active) for physical activity and a three-point scale (less healthy, unchanged, and healthier) for eating behavior. The World Health Organization (WHO) suggested that individuals should maintain unchanged or improve healthy lifestyles (healthy eating, physical activity) to stay healthy during the pandemic, especially in the lockdown period (46). In this study, participants with "never" and "unchanged" responses to physical activity were those who did not change their physical activity before and during the pandemic. However, a "never" reply was considered a negative behavior. In contrast, an "unchanged" response which means maintaining physical activity at a constant intensity, was considered a positive behavior during the pandemic. Therefore, we categorized physical activity and eating behavior changes into two groups: negative behaviors "never/stopped or less active" vs. positive behaviors "unchanged or more active" for physical activity, and negative behaviors "less healthy" vs. positive behaviors "unchanged or healthier" for eating behavior (43, 53).

We assessed the changes in participants' mental health using the question "How has your mental health changed compared to that before the pandemic?" Patients answered this question with three options, including 1 = "worse," 2 = "stable," and 3 = "better." To ease for analysis, we categorized mental health changes into two groups: "worse" vs. "stable or better" (38).

Digital Healthy Diet Literacy and Health Literacy

This study assessed the DDL and health literacy (HL) using the DDL-4 questionnaire and HLS-SF12 questionnaire, respectively. These instruments were developed, validated, and commonly used in previous studies in Vietnam (36, 38, 39, 43, 54–57). In the current study, the Cronbach's α of DDL-4 and HLS-SF12 tools were 0.96 and 0.95, respectively. The patients were asked to rank their difficulty to perform each questionnaire item on four-point responses from 1 = "very difficult" to 4 = "very easy." We then transformed DDL and HL scores into unified metrics with the ranges from 0 to 50, where participants with a greater DDL score or HL score had better DDL or HL. The formula was documented in prior papers (36, 58).

eHealth Literacy

Our study evaluated the eHEALS of participants using an eHealth literacy scale. This instrument consists of eight items, which were validated and utilized in the Vietnamese context (39, 43). The Cronbach's α of eHEALS was 0.96 in this study. Patients ranked their agreement with eight opinions regarding their

ability to identify and evaluate health information from online sources. The responses range from 1 = "strongly disagree" to 5 = "strongly agree." The sum scores were from 8 to 40, in which patients with a greater eHEALS score had better eHEALS.

Fear of COVID-19

The fear of COVID-19 scale (FCoV-19S) with seven items was used to assess the fear level of patients. This questionnaire was developed, validated, and used during the pandemic in different countries (59, 60), including Vietnam previous (39, 61). The Cronbach's α of this tool was 0.92 in our study. Patients ranked their consent with seven statements regarding their feelings related to COVID-19 infectability. The possible answers range from 1 = "strongly disagree" to 5 = "strongly agree." The answers were added up, and the sum scores were from 7 - 35, in which participants with a higher score presented a greater degree of fear of COVID-19.

Data Analysis

First, we presented independent variables (IVs) as the mean, standard deviation, frequency, and proportion appropriately. Missing data were handled by the pair-wise deletion method. Second, the Chi-squared test and one-way ANOVA test were appropriately performed to compare the proportion of three outcomes (changes in eating behavior, physical activity, and mental health) by different IVs. We used the Benjamini-Hochberg method to decrease the false discovery rate (FDR) when performing multiple comparisons. The raw *p*-values were adjusted to control the level of FDR at 5% using the Benjamini-Hochberg method. Third, we used unadjusted and adjusted logistic regression models to explore the associations of lockdown, DDL, and eHEALS with three outcomes. We chose IVs linked to outcomes at $p < 0.2$ in simple logistic regression models to put in adjusted models. We also performed the Spearman correlation test to check relationships between IVs to avoid multicollinearity. If a moderate or high ($rho \geq 0.30$) correlation was found between two IVs, we selected a representative one to adjust the final models. Finally, we performed interaction models to examine the modification effects of DDL and eHEALS on the associations between COVID-19 lockdown and three outcomes. If DDL or eHEALS was not associated with outcomes in adjusted logistic regression models, we did not perform the interaction analyses between lockdown and DDL or eHEALS for those outcomes. Unadjusted interaction models were run with three terms that were X1, X2, and X1 × X2. In which X1 is the main effect of lockdown ("Under lockdown × lowest DDL" or "under lockdown × lowest eHEALS"), X2 is the main effects of DDL or eHEALS ("After lockdown × 1-point increment of DDL" or "after lockdown × 1-point increment of eHEALS"), and X1×X2 is the interaction term ("Under lockdown × 1-point increment of DDL" or "under lockdown × 1-point increment of eHEALS"). Adjusted interaction models were tested with three interaction terms and potential confounders. For visualizing interactions, we conducted the simple slope analyses using PROCESS Marco version 3.5 in SPSS. Before performing simple slope tests, DDL and eHEALS were centralized with a new mean of zero. The graphs were drawn by calculating the expected probability of outcomes by the lockdown variable at three values of DDL or eHEALS (the mean, −1 SD, and +1 SD from the mean). We also reported the coefficients of conditional effects to calculate the odds ratios for the impacts of COVID-19 lockdown on outcomes at three values of DDL or eHEALS. The $p < 0.05$ was defined as a significant level. All analyses were conducted by the IBM SPSS Version 26.0 (IBM Corp, Armonk, NY, United States).

RESULTS

Characteristics of Participants

In 4,348 participants, the means of age (year), DDL scores, and eHEALS scores were 42.8 ± 16.7, 25.9 ± 12.2, and 27.9 ± 6.9, respectively. Out of all outpatients, 38.0% (1,654/4,348) were male, 17.8% (772/4,348) were never married, 89.1% (3,874/4,348) had a job, 62.5% (2,712/4,348) found it difficult to pay for medical care, 28.8% (1,254/4,348) had one or more comorbidities, 37.0 % (1,609/4,348) took the survey by online questionnaires. The percentages of outpatients with unchanged or healthier eating behavior, unchanged or more physical activity, and stable or better mental health were 92.5% (4,002/4,348), 42.1% (1,833/4,348), and 62.2% (2,705/4,348), respectively. The proportions of unchanged or healthier eating behavior, unchanged or more physical activity, and stable or better mental health were varied by different categories of age, gender (only for physical activity), marital status, education, occupation, ability to pay for medical care, social status (only for mental health), BMI (only for physical activity), COVID-19 lockdown, Slike-CV19S, comorbidity, health literacy, and fear of COVID-19 (only for mental health) (Benjamini-Hochberg adjusted $p < 0.05$) (**Table 1**). In addition, two groups "under lockdown" and "after lockdown" had differences in several characteristics, including age, gender, marital status, education, ability to pay for health care, social status, BMI, Slike-CV19S, comorbidity, HL, and fear of COVID-19 (**Table 1**).

Associations of COVID-19 Lockdown, Digital Healthy Diet Literacy, EHealth Literacy With Changes in Eating Behavior, Physical Activity, and Mental Health

After checking Spearman correlations between IVs, we found that age moderately correlates with education levels ($rho = -0.34$); ability to pay for medical care moderately correlates with social status ($rho = 0.30$); health literacy moderately correlates with comorbidities ($rho = -0.38$), and COVID-19-like symptoms ($rho = -0.34$) (**Supplementary Table 1**). Therefore, age, gender, ability to pay for medical care, health literacy, and other confounding factors associated with outcomes at $p < 0.2$ were added to adjusted logistic regression models (**Supplementary Table 2**).

The results of adjusted logistic regression models showed that patients under lockdown had a lower likelihood of having unchanged or healthier eating behavior (odds ratio, OR, 0.38; 95% confidence interval, 95% CI, 0.29 to 0.51; $p < 0.001$), unchanged or more physical activity (OR, 0.79; 95% CI, 0.69 to 0.90; $p < 0.001$), and stable or better mental health (OR, 0.77; 95%

TABLE 1 | Characteristics of outpatients by COVID-19 lockdown, and changes in eating behavior, physical activity, mental health (n = 4,348).

Variables	Total (n = 4,348)	COVID-19 lockdown			Eating behavior			Physical activity			Mental health		
		After lockdown (n = 1,972)	Under lockdown (n = 2,376)		Less healthy (n = 325)	Unchanged or healthier (n = 4,002)		Never/stopped or less active (n = 2,515)	Unchanged or more active (n = 1,833)		Worse MH (n = 1,643)	Stable or better MH (n = 2,705)	
	n (%)	n (%)	n (%)	p[a]	n (%)	n (%)	p[a]	n (%)	n (%)	p[a]	n (%)	n (%)	p[a]
Age (years), mean (SD)	42.8 (16.7)												
Age groups				<0.001			<0.001			<0.001			<0.001
<60	3,412 (78.5)	1,676 (85.0)	1,736 (73.1)		164 (50.5)	3,233 (80.8)		1,838 (73.1)	1,574 (85.9)		1,068 (65.0)	2,344 (86.7)	
≥60	936 (21.5)	296 (15.0)	640 (26.9)		161 (49.5)	769 (19.2)		677 (26.9)	259 (14.1)		575 (35.0)	361 (13.3)	
Gender				<0.001			0.129			0.009			0.155
Women	2,694 (62.0)	1,312 (66.5)	1,382 (58.2)		188 (57.8)	2,494 (62.3)		1,601 (63.7)	1,093 (59.6)		995 (60.6)	1,699 (62.8)	
Men	1,654 (38.0)	660 (33.5)	994 (41.8)		137 (42.2)	1,508 (37.7)		914 (36.3)	740 (40.4)		648 (39.4)	1,006 (37.2)	
Marital status				<0.001			0.030			<0.001			<0.001
Never married	772 (17.8)	480 (24.4)	292 (12.3)		43 (13.2)	726 (18.2)		343 (13.7)	429 (23.4)		204 (12.4)	568 (21.1)	
Ever married	3,560 (82.2)	1,485 (75.6)	2,075 (87.7)		282 (86.8)	3,261 (81.8)		2,156 (86.3)	1,404 (76.6)		1,438 (87.6)	2,122 (78.9)	
Education level				<0.001			<0.001			<0.001			0.007
Junior high school or lower	1,007 (23.2)	415 (21.1)	592 (24.9)		99 (30.6)	906 (22.7)		588 (23.4)	419 (22.9)		413 (25.2)	594 (22.0)	
Senior high school	1,196 (27.5)	465 (23.6)	731 (30.8)		106 (32.7)	1,079 (27.0)		759 (30.2)	437 (23.9)		471 (28.7)	725 (26.9)	
College/university or higher	2,139 (49.3)	1,088 (55.3)	1,051 (44.3)		119 (36.7)	2,012 (50.3)		1,163 (46.3)	976 (53.3)		758 (46.2)	1,381 (51.1)	
Occupational status				0.227			0.024			0.008			<0.001
No job	474 (10.9)	202 (10.2)	272 (11.4)		48 (14.8)	423 (10.6)		302 (12.0)	172 (9.4)		245 (14.9)	229 (8.5)	
Having a job	3,874 (89.1)	1,770 (89.8)	2,104 (88.6)		277 (85.2)	3,579 (89.4)		2,213 (88.0)	1,661 (90.6)		1,398 (85.1)	2,476 (91.5)	
Ability to pay for medical care				<0.001			<0.001			<0.001			<0.001
Very or fairly easy	1,626 (37.5)	1,063 (54.0)	1,649 (69.5)		253 (77.8)	2,442 (61.1)		1,698 (67.8)	1,014 (55.3)		1,167 (71.0)	1,545 (57.3)	
Very or fairly difficult	2,712 (62.5)	904 (46.0)	722 (30.5)		72 (22.2)	1,552 (38.9)		808 (32.2)	818 (44.7)		476 (29.0)	1,150 (42.7)	
Social status				0.005			0.129			0.422			<0.001
Low	921 (21.2)	379 (19.3)	542 (22.8)		58 (17.8)	863 (21.6)		543 (21.7)	378 (20.6)		433 (26.4)	488 (18.1)	
Middle or high	3,419 (78.8)	1,589 (80.7)	1,830 (77.2)		267 (82.2)	3,132 (78.4)		1,964 (78.3)	1,455 (79.4)		1,210 (73.6)	2,209 (81.9)	
BMI, kg/m^2				0.012			0.246			0.003			0.292
Underweight	398 (9.2)	195 (9.9)	203 (8.6)		23 (7.1)	372 (9.3)		205 (8.2)	193 (10.6)		139 (8.5)	259 (9.6)	
Normal weight	3,393 (78.0)	1,496 (76.2)	1,897 (80.0)		253 (78.1)	3,124 (78.3)		1,959 (78.1)	1,434 (78.4)		1,302 (79.5)	2,091 (77.5)	

(Continued)

TABLE 1 | Continued

Variables	Total (n = 4,348)	COVID-19 lockdown			Eating behavior			Physical activity			Mental health		
		After lockdown (n = 1,972)	Under lockdown (n = 2,376)		Less healthy (n = 325)	Unchanged or healthier (n = 4,002)		Never/stopped or less active (n = 2,515)	Unchanged or more active (n = 1,833)		Worse MH (n = 1,643)	Stable or better MH (n = 2,705)	
	n (%)	n (%)	n (%)	p^a	n (%)	n (%)	p^a	n (%)	n (%)	p^a	n (%)	n (%)	p^a
Overweight/obese	546 (12.6)	274 (13.9)	272 (11.5)		48 (14.8)	496 (12.4)		345 (13.8)	201 (11.0)		197 (12.0)	349 (12.9)	
COVID-19-like symptoms				<0.001			<0.001			<0.001			<0.001
No	2,595 (59.7)	1,343 (68.1)	1,252 (52.7)		115 (35.4)	2,473 (61.8)		1,223 (48.6)	1,372 (74.8)		567 (34.5)	2,028 (75.0)	
Yes	1,753 (40.3)	629 (31.9)	1,124 (47.3)		210 (64.6)	1,529 (38.2)		1,292 (51.4)	461 (25.2)		1,076 (65.5)	677 (25.0)	
Comorbidity				<0.001			<0.001			<0.001			<0.001
None	3,094 (71.2)	1,534 (77.7)	1,560 (65.6)		145 (44.6)	2,938 (73.4)		1,660 (66.0)	1,444 (78.7)		747 (45.4)	2,357 (87.1)	
One or more	1,254 (28.8)	438 (22.3)	816 (34.4)		180 (55.4)	1,064 (26.6)		855 (34.0)	389 (21.3)		896 (54.6)	348 (12.9)	
COVID-19 lockdown		–	–	–			<0.001			<0.001			<0.001
After lockdown	1,972 (45.4)	–	–	–	72 (22.2)	1,899 (47.5)		1,046 (41.6)	926 (50.5)		652 (39.7)	1,320 (48.8)	
Under lockdown	2,376 (54.6)	–	–	–	253 (77.8)	2,103 (52.5)		1,469 (58.4)	907 (49.5)		991 (60.3)	1,385 (51.2)	
Eating behavior changes				<0.001	–	–	–	–	–	–	–	–	–
Less healthy	325 (7.5)	72 (3.7)	253 (10.7)		–	–	–	–	–	–	–	–	–
Unchanged	3,169 (73.2)	1,517 (76.9)	1,652 (69.5)		–	–	–	–	–	–	–	–	–
Healthier	833 (19.3)	382 (19.4)	451 (19.8)		–	–	–	–	–	–	–	–	–
Physical activity changes				<0.001	–	–	–	–	–	–	–	–	–
Never	628 (14.4)	359 (18.2)	269 (11.3)		–	–	–	–	–	–	–	–	–
Stopped	285 (6.6)	101 (5.1)	184 (7.7)		–	–	–	–	–	–	–	–	–
Less active	1,602 (36.8)	586 (29.7)	1,016 (42.8)		–	–	–	–	–	–	–	–	–
Unchanged	1,188 (27.3)	608 (30.8)	580 (24.4)		–	–	–	–	–	–	–	–	–
More active	645 (14.9)	318 (16.2)	327 (13.8)		–	–	–	–	–	–	–	–	–
Mental health changes				<0.001	–	–	–	–	–	–	–	–	–
Worse	1,643 (37.8)	652 (33.1)	991 (41.7)		–	–	–	–	–	–	–	–	–
Stable	2,573 (59.2)	1,255 (63.6)	1,318 (55.5)		–	–	–	–	–	–	–	–	–
Better	132 (3.0)	65 (3.3)	67 (2.8)		–	–	–	–	–	–	–	–	–
HL, mean (SD)	26.5 (10.5)	26.9 (9.9)	26.1 (10.9)	0.026	24.7 (11.1)	26.5 (10.5)	0.004	24.7 (10.5)	28.9 (10.1)	<0.001	22.2 (9.9)	29.0 (9.9)	<0.001
eHEALS, mean (SD)	27.9 (6.9)	27.7 (7.2)	27.9 (6.7)	0.292	27.7 (5.2)	27.8 (7.0)	0.765	26.9 (6.9)	29.1 (6.8)	<0.001	25.3 (6.8)	29.4 (6.5)	<0.001
DDL, mean (SD)	25.9 (12.2)	26.2 (12.1)	25.6 (12.3)	0.105	22.5 (12.6)	26.1 (12.2)	<0.001	23.9 (12.2)	28.7 (11.7)	<0.001	20.8 (11.7)	28.9 (11.5)	<0.001
Fear of COVID-19, mean (SD)	20.6 (5.4)	20.9 (5.6)	20.2 (5.1)	<0.001	20.5 (4.8)	20.6 (5.4)	0.836	20.4 (5.3)	20.7 (5.5)	0.062	21.4 (5.1)	20.0 (5.5)	<0.001

MH, mental health; SD, standard deviation; DDL, digital healthy diet literacy; eHEALS, eHealth literacy; HL, health literacy.

[a]*Results of the Chi-square test or one-way ANOVA test appropriately with Benjamini-Hochberg adjusted p-values.*

CI, 0.67 to 0.89; $p < 0.001$) (**Table 2**). Conversely, participants with a higher DDL had a higher likelihood of having unchanged or healthier eating behavior (OR, 1.02; 95% CI, 1.01 to 1.03; $p = 0.043$), and stable or better mental health (OR, 1.02; 95% CI, 1.01 to 1.03; $p < 0.001$), while participants with a higher eHEALS had a higher likelihood of having unchanged or more physical activity (OR, 1.01; 95% CI, 1.00 to 1.03; $p = 0.043$), and stable or better mental health (OR, 1.06; 95% CI, 1.05 to 1.08; $p < 0.001$) (**Table 2**).

Effect Modification by Digital Healthy Diet Literacy and EHealth Literacy on the Associations of COVID-19 Lockdown With Changes in Eating Behavior, Physical Activity, and Mental Health

In the interaction model between COVID-19 lockdown and DDL on eating behavior changes, as compared to patients after the lockdown and with the lowest DDL score, those under lockdown and with the lowest DDL score had a lower likelihood of maintaining unchanged or healthier eating behavior (OR, 0.12; 95% CI, 0.06 to 0.23; $p < 0.001$), while those under lockdown and with one DDL-point increment had a higher likelihood of having unchanged or healthier eating behavior (OR, 1.05; 95% CI, 1.02 to 1.07; $p < 0.001$) (**Table 3**). **Figure 2** illustrated the change in the expected probability of unchanged or healthier eating by COVID-19 lockdown at three levels of DDL (the mean, −1 SD, and +1 SD from the mean). The negative impact of COVID-19 lockdown on unchanged or healthier eating was attenuated by higher DDL values from 1 SD below the mean (OR = 0.22, 95% CI, 0.15 to 0.34, $p < 0.001$), the mean (OR = 0.39, 95% CI, 0.30 to 0.54, $p < 0.001$), to 1 SD above the mean (OR = 0.70, 95% CI, 0.50 to 0.99, $p = 0.048$) (**Supplementary Table 3**). Overall, the significant interaction suggested that when DDL was higher, the inverse association between COVID-19 lockdown and eating behavior changes became weaker.

In the interaction model between COVID-19 lockdown and DDL on mental health changes, as compared patients after the lockdown and with the lowest DDL score, those under lockdown and with the lowest DDL score had lower odds of stable or better mental health (OR, 0.44; 95% CI, 0.32 to 0.61; $p < 0.001$), while those under lockdown and with one DDL-point increment had a higher likelihood of stable or better mental health (OR, 1.02; 95% CI, 1.01 to 1.04; $p < 0.001$) (**Table 3**). **Figure 3** showed the change in the expected probability of stable or better mental health by COVID-19 lockdown at three values of DDL. The negative impact of COVID-19 lockdown on stable or better mental health was attenuated by higher DDL values from 1 SD below the mean (OR = 0.60, 95% CI, 0.50 to 0.72, $p < 0.001$), the mean (OR = 0.79, 95% CI, 0.69 to 0.91, $p = 0.001$), to 1 SD above the mean (OR = 1.05, 95% CI, 0.84 to 1.30, $p = 0.665$) (**Supplementary Table 3**). Overall, the significant interaction suggested that when DDL was higher, the inverse association between COVID-19 lockdown and mental health changes became weaker.

In the interaction model between COVID-19 lockdown and eHEALS on physical activity changes, as compared to patients

TABLE 2 | Associations of COVID-19 lockdown, digital healthy diet literacy, eHealth literacy with changes in eating behavior, physical activity, and mental health ($n = 4,348$).

Variables[a]	Eating behavior changes[b]				Physical activity changes[c]				Mental health changes[d]			
	Unadjusted model		Adjusted model[e]		Unadjusted model		Adjusted model[f]		Unadjusted model		Adjusted model[g]	
	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p
COVID-19 lockdown												
After lockdown	1.00		1.00		1.00		1.00		1.00		1.00	
Under lockdown	0.32 (0.24, 0.41)	<0.001	0.45 (0.33, 0.62)	<0.001	0.69 (0.62, 0.79)	<0.001	0.79 (0.69, 0.90)	<0.001	0.69 (0.61, 0.79)	<0.001	0.77 (0.67, 0.89)	<0.001
Digital healthy diet literacy, 1-score increment	1.02 (1.01, 1.03)	<0.001	1.02 (1.00, 1.04)	0.018	1.03 (1.03, 1.04)	<0.001	1.01 (0.99, 1.02)	0.064	1.06 (1.05, 1.07)	<0.001	1.02 (1.01, 1.03)	<0.001
eHealth literacy, 1-score increment	1.00 (0.98, 1.02)	0.753	0.98 (0.96, 1.01)	0.206	1.05 (1.04, 1.06)	<0.001	1.01 (1.00, 1.03)	0.043	1.10 (1.09, 1.11)	<0.001	1.06 (1.05, 1.08)	<0.001

OR, odds ratio; CI, confidence interval.
[a]*Each independent variable was analyzed separately in different models.*
[b]*The reference group is "less healthy," the test group is "unchanged or healthier."*
[c]*The reference group is "never/stopped or less active," the test group is "unchanged or more active."*
[d]*The reference group is "worse," the test group is "stable or better."*
[e]*Adjusted for age, gender, marital status, occupational status, ability to pay for medical care, health literacy.*
[f]*Adjusted for age, gender, marital status, occupational status, ability to pay for medical care, BMI, health literacy, fear of COVID-19.*
[g]*Adjusted for age, gender, marital status, occupational status, ability to pay for medical care, health literacy, fear of COVID-19.*

TABLE 3 | Interactions of COVID-19 lockdown with digital healthy diet literacy and eHealth literacy on changes in eating behavior, physical activity, and mental health (n = 4,348).

Variables	Eating behavior changes[a]				Physical activity changes[b]				Mental health changes[c]			
	Unadjusted model		Adjusted model[d]		Unadjusted model		Adjusted model[e]		Unadjusted model		Adjusted model[f]	
	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*
Interaction of lockdown with DDL[g]												
After lockdown × lowest DDL	1.00		1.00		–	–	–	–	1.00		1.00	
Under lockdown × lowest DDL	0.10 (0.05, 0.18)	<0.001	0.13 (0.07, 0.26)	<0.001	–	–	–	–	0.42 (0.31, 0.57)	<0.001	0.44 (0.32, 0.61)	<0.001
After lockdown × DDL, 1-score increment	0.98 (0.97, 1.01)	0.148	0.98 (0.96, 1.01)	0.160	–	–	–	–	1.05 (1.04, 1.06)	<0.001	1.01 (1.00, 1.02)	0.057
Under lockdown × DDL, 1-score increment	1.05 (1.03, 1.07)	<0.001	1.05 (1.03, 1.07)	<0.001	–	–	–	–	1.02 (1.01, 1.03)	<0.001	1.02 (1.01, 1.04)	<0.001
Interaction of lockdown with eHEALS[h]												
After lockdown × lowest eHEALS	–	–	–	–	1.00		1.00		1.00		1.00	
Under lockdown × lowest eHEALS	–	–	–	–	0.30 (0.18, 0.51)	<0.001	0.31 (0.18, 0.53)	<0.001	1.55 (0.89, 2.71)	0.122	1.25 (0.69, 2.24)	0.458
After lockdown × eHEALS, 1-score increment	–	–	–	–	1.03 (1.02, 1.05)	<0.001	0.99 (0.98, 1.01)	0.671	1.12 (1.10, 1.14)	<0.001	1.08 (1.06, 1.09)	<0.001
Under lockdown × eHEALS, 1-score increment	–	–	–	–	1.03 (1.01, 1.05)	0.002	1.03 (1.01, 1.05)	0.001	0.97 (0.95, 0.99)	0.002	0.98 (0.96, 1.01)	0.065

OR, odds ratio; CI, confidence interval; DDL, digital healthy diet literacy; eHEALS, eHealth literacy.

[a] The reference group is "less healthy," the test group is "unchanged or healthier."

[b] The reference group is "never/stopped or less active," the test group is "unchanged or more active."

[c] The reference group is "worse," the test group is "stable or better."

[d] Adjusted for age, gender, marital status, occupational status, ability to pay for medical care, health literacy.

[e] Adjusted for age, gender, marital status, occupational status, ability to pay for medical care, BMI, health literacy, fear of COVID-19.

[f] Adjusted for age, gender, marital status, occupational status, ability to pay for medical care, health literacy, fear of COVID-19.

*[g] In **Table 2**, DDL was not associated with physical activity changes. Thus, the interaction model between lockdown and DDL on physical activity changes was not performed.*

*[h] In **Table 2**, eHEALS was not associated with eating behavior changes. Thus, the interaction model between lockdown and eHEALS on eating behavior changes was not performed.*

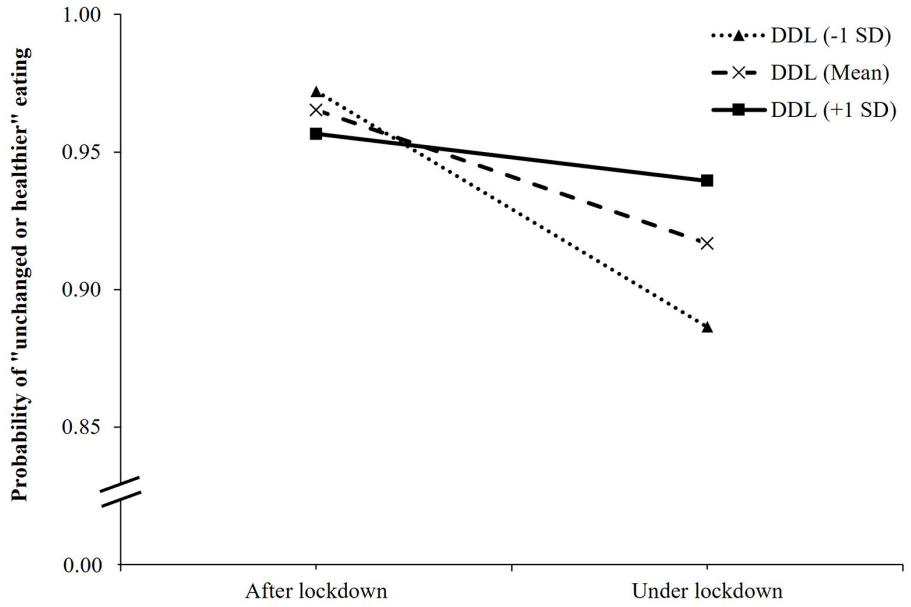

FIGURE 2 | Simple slope plot for interaction between lockdown and digital healthy diet literacy on eating behavior changes among outpatients ($n = 4,348$). DDL, digital healthy diet literacy; SD, standard deviation.

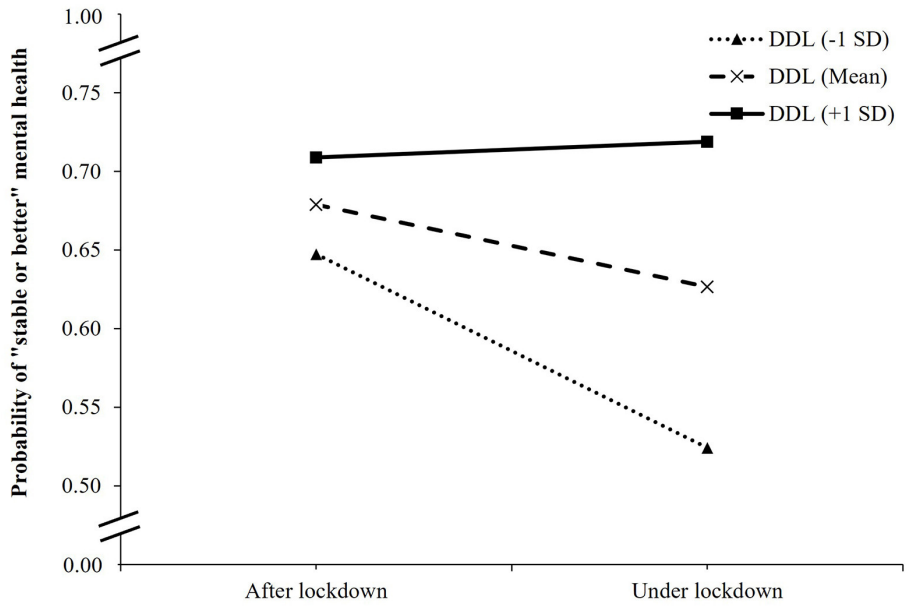

FIGURE 3 | Simple slope plot for interaction between lockdown and digital healthy diet literacy on mental health changes among outpatients ($n = 4,348$). DDL, digital healthy diet literacy; SD, standard deviation.

after the lockdown and with the lowest eHEALS score, those under lockdown and with the lowest eHEALS score had a lower likelihood of maintaining unchanged or more physical activity (OR, 0.31; 95% CI, 0.18 to 0.53; $p < 0.001$), while those under lockdown and with one eHEALS-point increment had higher odds of having an unchanged or more physical activity (OR, 1.03; 95% CI, 1.01 to 1.05; $p < 0.001$) (**Table 3**). **Figure 4** showed the change in the expected probability of unchanged or more physical activity by COVID-19 lockdown at three values of eHEALS. The negative impact of COVID-19 lockdown on unchanged or more physical activity was attenuated by higher eHEALS values from 1 SD below the mean (OR = 0.62, 95% CI, 0.52 to 0.75, $p < 0.001$), the mean (OR = 0.78, 95% CI, 0.68 to 0.89, $p < 0.001$), to 1 SD above the mean (OR = 0.98, 95%

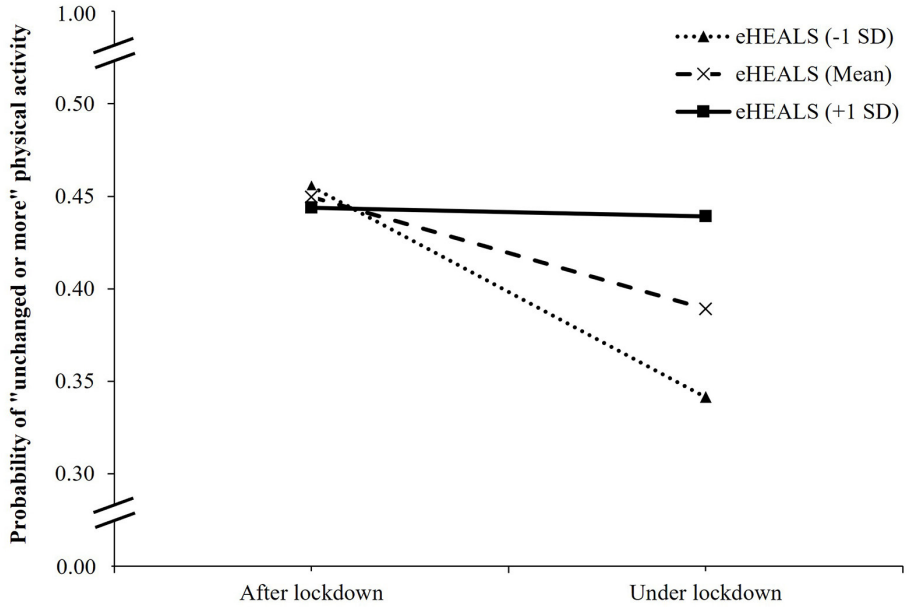

FIGURE 4 | Simple slope plot for interaction between lockdown and eHealth literacy on physical activity changes among outpatients (n = 4,348). Note: eHEALS, eHealth literacy; SD, standard deviation.

CI, 0.82 to 1.17, $p = 0.837$) (**Supplementary Table 3**). Overall, the significant interaction suggested that when eHEALS was higher, the inverse association between COVID-19 lockdown and physical activity changes became weaker.

DISCUSSION

Our findings highlighted the impacts of COVID-19 induced lockdown on changes in eating behavior, physical activity, mental health, and the modification effect of DDL and eHEALS on these associations in outpatients.

The current study found that the lockdown measure was negatively associated with maintaining unchanged or healthier eating behavior, unchanged or more physical activity, and stable or better mental health. A previous systematic review of 64 articles indicated that as compared with pre-lockdown, there was a decrease in physical activity in different populations during the lockdown period (25). Other studies conducted in different countries also showed that the COVID-19 lockdown or home confinement measures had harmful impacts on mental health and health-related behaviors with higher percentages of psychological disorders, physical inactivity, and unhealthy eating habits (11, 19, 23, 24, 62, 63). During the COVID-19 lockdown, restrictions on outside activities and travel, and limited food availability could cause negative changes in physical activity and dietary patterns (20–22, 25). In addition, the lockdown measure could adversely affect patients' mental health due to the difficulty in accessing medical care, delay in treatment, and feelings of boredom or isolation in the home confinement period (10, 11, 35). However, the current study did not study the potential impact of hospitalization and reasons of hospital visits on health-related behaviors, which might have biased the reported results. Therefore, appropriate strategies should be promoted to improve healthy lifestyles and psychological health during the COVID-19 lockdown.

Our study indicated that patients with higher DDL were more likely to have unchanged or healthier eating habits and stable or better psychological health during the pandemic. These findings are consistent with prior studies on front-line medical staff and healthcare students amidst the pandemic (36, 38). Importantly, we found that DDL could help to mitigate the adverse impacts of the lockdown measure on eating behavior and mental health. These findings could be explained that although there was a limited food availability and accessibility, patients with higher DDL may have the ability to evaluate and find for themselves a proper diet and avoid unhealthy foods (e.g., snacks, processed food) through reliable online health information sources during the COVID-19 lockdown. Meanwhile, higher DDL was found to be linked with higher health-related quality of life (39) and healthier eating behavior (36). Furthermore, the beneficial impacts of better dietary intake on psychological health were also documented in previous studies (53, 64, 65). Therefore, by improving the quality of life and diet, DDL could help patients to maintain stable or better mental health during the lockdown period.

Moreover, the results of this study demonstrated that higher eHEALS was associated with a higher likelihood of having unchanged or more physical activity and stable or better mental health. The role of eHEALS in maintaining positive health-related behaviors and protecting mental health has been reported in previous research (40–43). Furthermore, in the interaction

model, higher eHEALS could attenuate the harmful effects of COVID-19 induced lockdown on physical activity habits. An explanation for this association is that during the lockdown period, as people have to stay at home and restrict travel, they are more likely to engage in sedentary behaviors and increase screen time (66–68), which in the long term can cause weight gain and chronic diseases (63, 69). Patients with higher eHEALS have higher health awareness, and they have the skills to seek and identify suitable methods to help them maintain physical activity during the home confinement time. Maintaining a healthy diet and staying physically active are essential to improve physical and mental health during the pandemic, especially among people with health problems (46). Therefore, as the lockdown measure was implemented in many countries, enhancing EHL and DDL is critical to help patients to evaluate and identify trusted health information and make the right decisions about their health-related behavior and health.

In the present study, although the magnitude of changes in eating behavior, physical activity, and mental health during and after the lockdown was not substantial, statistically significant results also indicated a negative impact of COVID-19 lockdown on such changes in the short term. In the long run, when the COVID-19 pandemic is uncertain and the lockdown is prolonged, those changes may be more significant and worse without appropriate interventions. Therefore, with a relatively large sample size collected in many hospitals, our research has suggested timely evidence about the adverse impact of lockdowns and protective factors, which may help policymakers develop proper strategies to improve lifestyles and psychological health. In addition, some findings of this study (e.g., associations of DDL and eHEALS with physical activity changes) indicated that a 1-point increase in DDL or eHEALS resulted in a 1% increase in the proportion of unchanged or more physical activity. Although the size of the effects was not large, it would be meaningful if DDL and eHEALS enhancement interventions were implemented comprehensively. It could help people and patients to improve all skills in DDL or eHEALS, not just a specific skill. Therefore, DDL or eHEALS could be enhanced better, leading to a broader and more significant impact of DDL or eHEALS on the outcomes. Besides, mitigating the adverse impact of COVID-19 lockdown may depend on other factors, such as social security policies, food security, unemployment. Therefore, the results of the current study on improving DDL or eHEALS could provide substantive implications, helping patients to improve health-related behaviors and mental health, not only during the lockdown period but also in normal life.

Our study has several drawbacks. First, the causal relationship cannot be inferred from a cross-sectional study. Second, given the urgency of providing timely preliminary evidence for interventions in the initial stage of the pandemic, we used the consecutive convenience sampling method to recruit as many participants as possible. However, we had no data about patients approached in this survey, and only patients who agreed to join and completed the study were recorded. In addition, the total number of patients who visited hospitals during the study period was not recorded and not available on the system. Therefore, we cannot calculate the response rate of this study, which may affect the generalizability of our findings. Third, we used secondary data to analyze the associations in the present study, leading to an increase in the false discovery rate when testing multiple hypotheses on the same sample. Thus, the Benjamini-Hochberg method was used to adjust the *p*-value. Fourth, changes in eating behavior, physical activity, and mental health were assessed using single-item questionnaires, which may be subjective and cause reporting bias. In addition, the current study evaluated the change in physical activity with five answer options: never, stopped, less active, unchanged, and more active. However, the response "never" is an absolute answer that has not changed before and during the pandemic. Besides, it was also assumed that people who were never physically active might improve their behavior over time during the pandemic, while they could not make their physical activity worse than "never." Due to a cross-sectional study, we classified the "never" response as a negative behavior, which may cause some bias in the classification of physical activity changes. Therefore, results related to physical activity in this study should be applied with caution. Future studies also need to use a better approach for the assessment and classification of these outcomes. Next, we collected data using online and printed versions of the questionnaire, which may affect the results of this study. In addition, because comorbidities and health literacy were moderately correlated ($rho = -0.38$), we chose health literacy to adjust in the final models. However, it is suspected that the findings of this study may be affected by comorbidities. Therefore, we conducted the sensitivity analyses, which added comorbidities ("none" vs. "one or more") and questionnaire types ("online" vs. "printed") to adjust in final models. The results showed that the associations and interactions remained significant (**Supplementary Tables 4**, **5**). Finally, other variables influencing outcomes of this study, such as food insecurity, financial difficulty, social support, should be studied in future research.

CONCLUSION

The COVID-19 induced lockdown could negatively affect changes in eating behavior, physical activity, and mental health among outpatients. Digital healthy diet literacy and eHealth literacy could help to alleviate the adverse impacts of the COVID-19 induced lockdown on eating behavior, physical activity, and psychological health. Therefore, health organizations and policymakers should promote appropriate interventions to enhance DDL and eHEALS, which help patients to maintain their healthy lifestyles and protect mental health during the lockdown period. However, this study holds several limitations that may undermine the certainty of reported findings.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available on reasonable request to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Hanoi University of Public Health, Vietnam (IRB Number: 133/2020/YTCC-HD3). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

ThamN, MN, TP, V-TL, TaN, TL, BD, HD, HN, TH, LP, PN, HoN, TDo, HuN, MT, TL, AT, ThaoN, KN, DP, KP, C-HB, and TDu: conceptualization, methodology, validation, investigation, data curation, and writing review and editing draft. MN, ThamN, and TDu: formal analysis and writing-original draft. MN, TP, and ThaoN: project administration. TDu: supervision and funding acquisition. All authors have read and approved the final manuscript.

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Factors Associated With Dietary Quality During Initial and Later Stages of the COVID-19 Pandemic in Mexico

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Background: The COVID-19 pandemic disrupted the global economy and modified lifestyles. The aim of our study was to identify factors associated with dietary quality, and their frequency, in Mexican adults at the initial and later stages of the pandemic.

Methods: Two online surveys were conducted between June and July 2020 ($n = 3,131$) and between November and December 2020 ($n = 1,703$ including non-participants from 1st round). A diet quality score was estimated using a short instrument to measure the consumption of several healthy/unhealthy food items. Linear regression models were used to identify the association between pandemic related factors and the diet quality score, adjusted by sociodemographic characteristics. The 2nd round was weighted to represent the 1st round.

Results: During the 1st and 2nd rounds only ∼12% of the sample perceived that their intake of healthy food decreased, relative to before the pandemic; ∼20% perceived that their intake of unhealthy foods increased. Diet quality remained similar between the 1st and 2nd round. The following factors were negatively associated with diet quality: Eating food prepared away-from-home; going out to work ≥4 times/week; decreased time for food preparation; decreased interest in eating healthy; eating more due to anxiety, depression, or boredom; food insecurity; and stockpiling junk food. Purchasing food using a mixed modality of both in-store and home delivery was positively associated with diet quality. With the exception of eating more due to anxiety (reported by 47% of participants), all these factors were reported by a minority of participants during the first round (≤15%). During the 2nd round, there was an increase in the frequency of participants who reported eating food prepared away-from-home, going out to work ≥4 times/week, having less time to prepare food, being more interested in eating healthfully, and a decrease in participants eating more due to anxiety, depression or boredom, or stockpiling junk food.

Conclusions: Most participants perceived that their dietary intake improved during both initial and later stages of the pandemic. This might be related to factors associated with

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higher dietary quality, such as not going out to work, eating homemade food, and online grocery shopping.

Keywords: COVID-19, lockdown, diet quality, Mexico, adults

INTRODUCTION

Mexico documented its first case of COVID-19 on February 27th, 2020. In little over two months, close to 20,000 confirmed cases were registered (1). A year later, over two million cases and 228,000 deaths had been officially documented in the country (2). In an effort to slow the spread of COVID-19 in the country, a national public health emergency was declared in March 2020. While mandatory lockdowns or curfews were never in place, federal government efforts promoted a stay-at-home campaign ("Quédate en Casa") and encouraged social distancing measures (3). Nationwide, all educational institutions remained closed for over 15 months, some re- opening on June 7th, 2021. From mid-march to the end of May 2020, only essential economic activities were permitted, and from June 2020 onwards, a state-specific traffic light system was established to indicate the level of economic activities permitted, as well as the use of public spaces according to the risk of infection by SARS-COV-2.

Concerns have been raised about the impact of COVID-19 on the nutritional status of individuals (4, 5). The Mexican population was already nutritionally vulnerable prior to the start of the COVID-19 pandemic. Over 55% of Mexican households have some degree of food insecurity (6). Overweight and obesity are widespread, affecting 70% of Mexican adults, close to 40% of adolescents, and 35% of children (7, 8). Undernutrition and micronutrient deficiencies are also enduring public health challenges among segments of the population (9). The elevated consumption of foods that are high in saturated fat and/or added sugar and low nutrient density (discretionary foods) and sugar-sweetened beverages, coupled with inadequate consumption of essential foods such as fruits, vegetables and legumes before the pandemic, are known to have contributed to the double burden of malnutrition (10, 11). The economic implications of the pandemic, alongside those resulting from confinement and social distancing measures predictably influenced access to food, food security, purchasing behaviors, dietary patterns, and general lifestyle (12–14).

Understanding the impact of the COVID-19 pandemic on nutrition-related behaviors—in the short and long term—is imperative. Surveys conducted to date around the world have shown mixed findings, with some segments of the population reporting improvement in dietary habits while others reporting the opposite (even within the same survey) (15–20). In Mexico and Latin America, most studies report either no change or an improvement in dietary habits (19–22). Results from the Brazilian NutriNet cohort comparing food intake in adults before and during the confinement period show an overall increase in the intake of fruits, vegetables, and legumes, and no significant change in the intake of ultra-processed foods (20). In a cross-sectional online survey disseminated trough social media during the confinement period in several Ibero-American countries, it was found that in Argentina, Brazil, Mexico, and Peru, most participants reported no change in their dietary habits compared to before confinement, and among those who changed their diet, the majority of participants from all countries except for Peru did so toward a healthier diet (19). Other online surveys in Mexico report a perceived increase in diet quality during quarantine (21) or a higher percentage of participants that report having a healthy diet during confinement compared to before confinement, but also 30 to 50% that report increasing their intake of sweets, desserts, sugar-sweetened beverages, and/or junk food (22). Yet, in low- and middle-income countries, including Mexico, an increase in food insecurity has been reported, as well as a decrease in diet diversity, particularly among those from low socioeconomic status (SES) (13, 23). These discrepancies could result from the interplay between individual characteristics and the specific context or life situation faced during the pandemic. Hence, assessing the relation between factors related to the pandemic and dietary quality, and in which segments of the population these factors were more frequent, can assist in better understanding the impact of the pandemic on dietary quality.

We conducted two online surveys among Mexican adults at initial and later stages of the pandemic. Our aim was to identify self-perceived changes in dietary habits and to evaluate the association between pandemic-related factors (e.g., home confinement, grocery shopping mode, consumption of food prepared away-from-home, emotional eating, food insecurity, changes in income, free time, time for cooking, interest in healthy eating, etc.) and diet quality. In addition, we identified the frequency of these pandemic-related factors during initial and late stages of the pandemic (1st and 2nd round) and their distribution according to sociodemographic and individual characteristics.

METHODS

Study Population

We conducted two online surveys among Mexican adults, the 1st round between June 24th and July 27th, 2020, and the 2nd round between November 12th and December 16th, 2020. The first survey was conducted when the pandemic was in its initial stages and the second almost a half year later when the novelty of the pandemic had decreased and there were less restrictions. At the time of the 1st survey, mobility nationwide had been reduced by 40–70% and by the time the 2nd survey was conducted, mobility was down by 10–45% (24). Both surveys included the same questionnaire. Inclusion criteria were being age 18 or older and living in Mexico at the time of the survey. The 1st online survey round was disseminated

Abbreviations: SES, socioeconomic status.

through the institutional social media accounts of the Mexican National Institute of Public Health (INSP) and the World Food Programme (WFP), partner institutions, civil society, and the authors' personal social media networks. Paid advertisements on Facebook were also used to enhance the reach and diversity of the sample. The same diffusion strategy was used for the 2nd round and, in addition, email invitations were sent to 1st round participants who voluntarily provided an email for follow-up. The 2nd round was open to subjects that did not participate in the 1st round. Informed consent was obtained from each participant prior to starting the survey. The survey protocol was reviewed and approved by the Research and Ethics Committees of the INSP.

Surveys were collected through MODA (Mobile Operational Data Acquisition), the web-based platform used by the World Food Programme for data collection. The instrument was pilot tested before data collection, included 49 questions and took 10 to 15 min to complete. Participants were required to answer all questions to submit the survey. A total of 3,131 adults participated in the 1st round and 1,703 in the 2nd round (from which 766 reported participating in the 1st round and 522 were confirmed to have participated in both rounds by matching their email addresses).

Questionnaire Sections

Sociodemographic and Individual Characteristics

Sociodemographic variables collected included sex, age, marital status, geographical location (state/municipality), occupation before and after the start of the pandemic, head of the household education level, household composition, and government support benefits. SES was assessed using the Mexican Association of Market Research Agencies and Public Opinion Index (25). This index classifies households into seven strata (from higher to lower: A/B, C+, C, C–, D+, D, E) based on six variables (number of bathrooms, rooms, vehicles, household members working, internet connection, and head of household education level). Employing this widely used index allowed us to compare the SES of our sample to that of the general Mexican population. Additionally, an individual characteristic regarding the importance attributed to health and nutrition was collected by asking the participants how often they usually choose foods according to their healthfulness (hereafter referred to as *healthy food consciousness*).

Diet Quality

To assess diet quality, participants were asked to recall all foods consumed the previous day and select them from a list of 31 food items. Quantities consumed were not measured. Food items were grouped into seven food categories (vegetables, fruits, animal and plant sources of protein, cereals, sweets, snacks, and ready-to-eat foods and beverages). Each category included the option "I did not consume any of the foods listed above," intended as a prompt for the participant, but also to ensure that he/she selected at least one option from each category, given that an answer to all questions was required (**Supplementary Table 1**). To conform the diet quality score, points were assigned for the intake of each healthy item or the non-intake of each unhealthy item. Healthy items included fruits, vegetables, legumes, nuts and seeds, poultry, fish, eggs, and unsweetened grains. Unhealthy items included processed meat, sweets, snacks, ready-to-eat meals, and sugary beverages. The maximum score was 100 points (**Supplementary Table 2**). Further details about the development and performance of this instrument and the diet quality score in relation to 24-hr dietary recall data from the National Health and Nutrition Survey are described in the **Supplementary Material** section. We found that this score had a small correlation with micronutrient adequacy, and in the case of fiber, saturated fat, and added sugar it had a moderate correlation that was comparable to those found with more intricate diet quality indicators, such as the Alternate Healthy Eating Index-2010 or the energy share of ultra-processed foods (**Supplementary Table 3**) (26, 27).

Perceived Changes in Diet, Physical Activity, and Body Weight

Perceived changes in diet were assessed with the following questions: "Since the start of the pandemic, has your intake of healthy foods such as fruits, vegetables, whole grains, legumes, or plain water changed?", and "Since the start of the pandemic, has your intake of unhealthy foods such as chips, sodas, cookies, or pastries changed?", with the response options: decreased, increased, or unchanged. Participants were also asked about perceived changes in physical activity patterns and body weight (same response options). One of the response options perceived changes in body weight was being pregnant or in post-partum.

Pandemic-Related Factors

We were interested in identifying factors that were potentially affected or modified since the onset of the pandemic and that could, in turn, affect dietary intake (we refer hereafter to these factors as *pandemic-related factors)*. These factors included the level of home confinement during the previous 2-weeks; the consumption of food prepared away-from-home the previous day; shopping modality from grocery stores and traditional or street markets (*tianguis*) during the previous 2-weeks; household income changes since the start of the pandemic; perceived changes in free time; perceived time spent cooking; perceived interest in eating healthy; eating more due to anxiety, depression or boredom; food insecurity in the previous week; and food stockpiling or purchasing more than usual due to fear of scarcity. All prior questions referred to the time of the survey or to the perceived change from before the pandemic to the time of the survey. Only the shopping modality-related questions included additional questions regarding shopping habits before the onset of the pandemic.

An additional pandemic-related factor was the state-specific restriction level according to the traffic light system of epidemiological risk, which was obtained for each participant based on the date they answered the survey and their state of residence. The traffic light system

TABLE 1 | Sociodemographic and individual characteristics and mean diet quality score.

	First survey round (Jun–Jul 2020) (n = 3,131)		Second survey round (Nov–Dec 2020) (n = 1,703)		
	n	%	n	Unweighted %	Weighted[a] %
Sex					
Female	2,367	75.6	1,366	80.2	77.2
Male	764	24.4	337	19.8	22.9
Age, %					
18–30 years	762	24.3	595	34.9	27.8
31–40 years	987	31.5	514	30.2	31.0
41–50 years	637	20.3	297	17.4	19.8
51–60 years	429	13.7	175	10.3	12.4
>60 years	316	10.1	122	7.2	9.0
Marital Status					
Single	1,096	35.0	754	44.3	37.9
Married or with partner	1,732	55.3	826	48.5	53.2
Divorced/separated/widowed	303	9.7	123	7.2	8.9
Head of the household highest education level					
Secondary school or less	231	7.4	175	10.3	8.1
High school	337	10.8	165	9.7	10.3
Bachelor degree	1,344	42.9	715	42.0	42.5
Graduate degree	1,219	38.9	648	38.0	39.1
Main occupation before the pandemic					
Student or working	2,275	72.7	1,140	66.9	71.0
Other	856	27.3	563	33.1	29.0
Socioeconomic status					
High (A/B)	647	20.7	398	23.4	21.4
Middle high (C+)	1,214	38.8	646	37.9	38.6
Middle low (C and C–)	1,131	36.1	593	34.8	35.8
Low (D+ and D)	139	4.4	66	3.9	4.2
Beneficiary of social programs					
None	2,930	93.6	1,603	94.1	93.5
Financial aid	111	3.6	50	2.9	3.5
Other	90	2.9	50	2.9	3.0
Geographical region					
South	593	18.9	303	17.8	18.4
Center	665	21.2	432	25.4	22.5
North	367	11.7	178	10.5	11.1
Mexico City Metropolitan Area	1,245	39.8	690	40.5	40.3
Guadalajara Metropolitan Area	261	8.3	100	5.9	7.8
Municipality population size					
≥1,00,000 habs.	2,865	91.5	1,509	88.6	90.7
<1,00,000 habs.	266	8.5	194	11.4	9.3
Household with children (<18 years)					
No	1,887	60.3	1,035	60.8	60.5
Yes	1,244	39.7	668	39.2	39.5
Healthy food consciousness					
Always	868	27.7	441	25.9	27.2
Almost always	1,666	53.2	944	55.4	54.2
Sometimes or never	597	19.1	318	18.7	19.6
	n	Mean (95% CI)	n	Unweighted mean (95% CI)	Weighted[a] mean (95% CI)
Diet quality score	3,131	64.1 (63.8, 64.5)	1,703	64.3 (63.7, 64.8)	64.4 (63.9, 64.9)

[a]*Weighted to maintain the distribution of sociodemographic variables of 1st round's participants.*

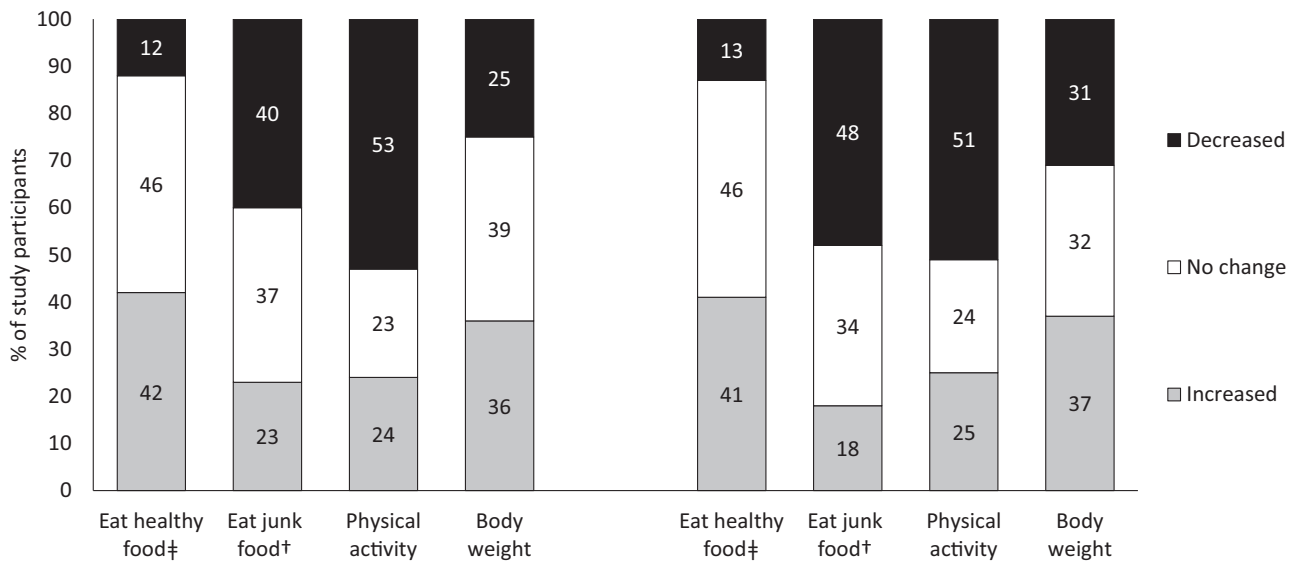

FIGURE 1 | Perceived changes in diet, physical activity and body weight, between pre-pandemic to initial and later stages of COVID-19 pandemic (1st and 2nd survey round). *Weighted to maintain the distribution of sociodemographic variables of 1st round's participants. ‡Fruit, vegetables, whole grains, legumes, plain water. †Chips, sodas, cookies, pastries.

considers four stages (red: maximum risk, only essential economic activities allowed; orange: high risk, non-essential economic activities at 30% capacity; yellow: moderate risk, only indoor public spaces at reduced capacity; and green: low risk, all activities functioning normally with basic prevention measures).

Statistical Analysis

For each survey round, descriptive statistics were calculated to show the distribution of sociodemographic variables, food shopping modality (e.g., in-store vs. home delivery) before the pandemic and at the time of the survey, and perceived changes in diet, physical activity, and body weight. We estimated the mean diet quality score by sociodemographic and individual characteristics and ran unadjusted linear regression models to evaluate these associations.

To evaluate the association between pandemic-related factors and diet quality, we used linear regression models with diet quality score as the dependent variable and the pandemic-related factors as the independent variables. For each pandemic-related factor, we ran two models: (1) adjusted by covariates (sociodemographic and individual characteristics), and (2) additionally adjusted by all other pandemic-related factors. Our model of interest was the first one as we did not consider pandemic-related factors as confounders of each other. However, because it might be of interest to identify its independent association with diet quality, we included the second model.

Model 1

$$Y\left(\textit{Diet quality score}\right) = a_0 + \beta 1\left(\textit{pandemic factor } 1\right) + \gamma\,\textit{Covariates} + e$$

Model 2

$$Y\left(\textit{Diet quality score}\right) = a_0 + \beta 1\left(\textit{pandemic factor } 1\right) + \beta 2\left(\textit{pandemic factor } 2\right) + \beta n\left(\textit{pandemic factor } n\right) + \gamma\,\textit{Covariates} + e$$

We identified the frequency with which pandemic-related factors that were positively or negatively associated with diet quality were present in our sample. We also identified if the frequency differed by sociodemographic and individual characteristics such as sex, age, SES, and healthy food consciousness with a chi-square test.

For the analysis of the 2nd survey round, participants were weighted to be representative of the participants of the first round. Inverse Probability Weights (IPW) are a way to deal with missing data, account for lost to follow-up, and achieve comparability across rounds of data collection in longitudinal studies (28–30). We estimated IPW with the inverse of the probability of being in the second round (vs. the first) conditional on all sociodemographic variables. To estimate the weights, we ran a logistic regression with the survey round regressed on the sociodemographic variables and we obtained the estimated predicted probabilities. Instead of including 1 in the numerator

when estimating the inverse, we stabilized the weights by including in the numerator the probability of being in the second round (not conditioning on any variable) (28).

$$IPW = \frac{\text{P(2nd round)}}{\text{P(2nd round | Covariates)}}$$

Our primary analysis was with all participants of the 2nd round ($n = 1{,}703$), but in the **Supplementary Material** we also present results with the subsample that reported participating in 1st round ($n = 766$), and with the subsample in which participation in the 1st round was confirmed and linked to an email ($n = 522$). The analysis was conducted in STATA 15 (StataCorp, College Station, TX). For all analyses, we used a p-value < 0.05 to consider results significant. Furthermore, weighted estimations were obtained with the "svy" STATA module.

RESULTS

Sample Characteristics

The 1st round of the survey was predominantly completed by women (76%) and the mean age of participants was 41. Participants from all states of Mexico were surveyed, but the majority were from Mexico City Metropolitan Area (40%). Almost all participants (92%) lived in highly urbanized municipalities (≥100,000 habitants). Overall, the education level of the head of household was high (43% had a bachelor's degree and 39% a graduate degree), and the majority were from high and middle SES. The majority (80%) reported choosing foods based on their healthiness always or almost always (healthy food consciousness). For the 2nd round, there were more females, young (18–30 years) and single participants compared to 1st round. Weighting the estimations of the 2nd round achieved comparability in the distribution between the two samples. The mean diet quality score was 64.2 (out of 100 possible points) in the 1st round and 64.4 in the 2nd round (**Table 1**). Diet quality was higher among individuals with the following characteristics: Female, older, married or with a partner, higher education, not studying or working, middle-high SES, receiving financial aid, with no children living in the same household, and more healthy food conscious (**Supplementary Table 4**).

Perceived Changes in Diet, Physical Activity, and Weight During the COVID-19 Pandemic

During the 1st round, 42% of the study sample perceived that their intake of healthy foods increased during lockdown and 40% perceived that their intake of unhealthy foods decreased. Half of the sample perceived that the time they spent on physical activity decreased. Excluding pregnant or post-partum participants, 39% of respondents perceived unchanged weight, 36% increased weight, and 25% perceived a decrease in weight. During the 2nd survey round, results (weighted to maintain comparability with 1st round) were similar, except that the proportion that perceived that their intake of unhealthy foods decreased during lockdown reached 48% (**Figure 1**).

TABLE 2 | Association between pandemic related-factors and diet quality score during the 1st survey round.

	Model 1	Model 2
Food prepared away-from-home the day before		
None	0 (ref)	0 (ref)
Restaurant (includes take-out and delivery)	−2.6 (−3.6, −1.6)	−2.2 (−3.2, −1.3)
Street vendors	−8.1 (−10, −6.1)	−7.5 (−9.5, −5.6)
Traditional or street market purchases, now		
In-store	0 (ref)	0 (ref)
In-store and home delivery	3.2 (0.7, 5.7)	3.1 (0.7, 5.5)
Home delivery	1.1 (0, 2.3)	1.0 (−0.2, 2.1)
None	−0.7 (−1.5, 0.1)	−0.9 (−1.7, −0.1)
Grocery store purchases, now		
In-store	0 (ref)	0 (ref)
In-store and home delivery	2.0 (0.7, 3.3)	2.0 (0.7, 3.3)
Home delivery	0.2 (−0.8, 1.1)	0.0 (−1.0, 0.9)
None	0.8 (−0.2, 1.8)	0.4 (−0.6, 1.4)
Level of home confinement		
Going out for motives other than work	0 (ref)	0 (ref)
Not leaving the home	−0.7 (−2, 0.7)	−0.8 (−2.1, 0.6)
Going out to work ≤3 times/week	−0.7 (−1.6, 0.3)	−0.7 (−1.6, 0.2)
Going out to work ≥4 times/week	−2.1 (−3.1, −1.1)	−1.6 (−2.6, −0.6)
Income changes		
No change	0 (ref)	0 (ref)
Increased	0.7 (−1.7, 3.2)	1.7 (−0.7, 4.1)
Decreased somewhat	−0.1 (−1, 0.7)	−0.2 (−1, 0.6)
Decreased a lot	0.2 (−0.7, 1.1)	0.9 (0, 1.9)
Perceived change in free time		
No change	0 (ref)	0 (ref)
Decreased	0.4 (−0.6, 1.5)	0.8 (−0.2, 1.8)
Increased	0.8 (−0.1, 1.7)	0.7 (−0.2, 1.6)
Perceived change in time for cooking		
No change	0 (ref)	0 (ref)
Decreased	−2.9 (−4.9, −1)	−0.9 (−2.8, 1)
Increased	1 (0.1, 2)	0.9 (0, 1.8)
Food is prepared by others	−0.9 (−2, 0.2)	−0.6 (1.7, 0.4)
Perceived change in interest in eating healthy		
No change	0 (ref)	0 (ref)
Decreased	−4.4 (−5.8, −3)	−3.1 (−4.5, −1.7)
Increased	1 (0.3, 1.7)	0.7 (0, 1.4)
Eating more due to anxiety, depression or boredom		
No	0 (ref)	0 (ref)
Yes	−2.4 (−3.1, −1.7)	−1.7 (−2.4, −1)
Food insecurity[a]		
No difficulty	0 (ref)	0 (ref)
Cheaper foods or that I enjoy less	−0.7 (−1.7, 0.3)	−0.5 (−1.6, 0.5)
Skip meals, eat less, or do not eat in an entire day	−3.5 (−4.9, −2.1)	−3.3 (−4.8, −1.9)
Stockpiling food		
None	0 (ref)	0 (ref)
Only basic foods	0.6 (−0.1, 1.3)	0.5 (−0.2, 1.3)
Junk food	−4.9 (−6.3, −3.5)	−4.3 (−5.7, −2.9)
Restriction level		
Orange	0 (ref)	0 (ref)
Red	−0.3 (−1.0, 0.4)	−0.1 (−0.8, 0.6)

[a] *Dificulty eating enough due to economic constraints.*

Model 1 adjusted by sex, age category, marital status, education level from head of household, main occupation before the pandemic, SES, beneficiary of social programs, geographic region, municipality population size, household with children, and healthy food consciousness.

Model 2 adjusted by covariates from Model 2, plus all the other pandemic-factors listed in this table.

TABLE 3 | Frequency of pandemic related factors negatively and positively associated with dietary quality by survey, sociodemographic, and individual characteristics.

	1st Survey (Jun–Jul 2020)										
	Survey round		Sex		Age		Socioeconomic status			Healthy food consciousness[a]	
	1st	2nd[b]	F	M	≤60	>60	High (A/B)	Middle (C+ / C-)	Low (D+ / D)	High	Low
Factors negatively associated with dietary quality											
Eating from restaurant (includes take-out and delivery) the day before	15	21*	14	18*	16	11*	17	15	14	15	20*
Eating from street vendors the day before	4	5*	3	4	3	1*	3	3	4	3	7*
Going out to work ≥4 times/week	15	25*	14	20*	17	5*	16	15	24*	15	21*
Perceived decreased time for cooking	4	7*	4	2*	4	4	3	4	9*	4	5
Perceived decreased interest in eating healthy	7	7	8	6	8	4*	7	7	12	6	15*
Eating more due to anxiety, depression or boredom	47	42*	50	39*	49	28*	47	46	58*	45	61*
Food insecurity (skip meals, eat less, or do not eat in an entire day)[c]	7	5	7	6	7	2*	3	7	25*	6	9*
Stockpiling junk food	7	4*	7	5	7	3*	9	6	2*	5	11*
Factors positively associated with dietary quality											
Purchasing in-store and home delivery from traditional or street markets	2	2	2	3	2	1	1	2	4	2	1
Purchasing in-store and home delivery from grocery stores	8	6*	8	7	8	5	10	8	3*	8	6
Perceived increased time for cooking	52	44*	56	41*	53	47*	49	53	49	53	45*
Perceived increased interest in eating healthy	52	57*	51	55*	53	41*	49	52	48	51	47*

[a] *High: always or almost always choose foods according to their healthfulness; Low: sometimes or never.*
[b] *Weighted to maintain the distribution of sociodemographic variables of first round's participants.*
[c] *Dificulty eating enough due to economic constraints.*
**p value < 0.05.*

Association Between Pandemic-Related Factors and Diet Quality

In **Table 2**, we present the association between the pandemic-related factors and diet quality during the 1st survey round. Adjusted by covariates (Model 1), the following pandemic-related factors had a statistically significant negative association with diet quality: Eating food prepared away-from-home compared to not doing so [−2.6 (95% CI: −3.6, −1.6) from restaurants and −8.1 (−10.0, −6.1) from street vendors]; going out to work ≥4 times/week compared to going out for motives other than work [−2.1 (−3.1, −1.1)]; decreased interest in eating healthy during lockdown compared to no change [−4.4 (−5.8, −3.0)]; eating more due to anxiety, depression or boredom compared to not doing so [−2.4 (−3.1, −1.7)]; skipping meals, eating less, or not eating in an entire day due to economic constraints (food insecurity) compared to not having difficulty [−3.5 (−4.9, −2.1)]; and stockpiling junk food compared to not stockpiling any kind of food [−4.9 (−6.3, −3.5)]. In comparison to no change during lockdown, decreased time for cooking was negatively associated [−2.9 (−4.9, −1.0)] and increased time was positively associated with diet quality [1.0 (0.1, 2.0)]. Finally, purchasing food with a combination of in-store and home delivery was associated with increased diet quality for both traditional/street markets [3.2 (0.7, 5.7)] and grocery stores [2.0 (0.7, 3.3)]. Further adjusting by all other pandemic-related factors (Model 2) weakened the association in most cases. Results were similar for the 2nd survey round (**Supplementary Table 5**).

Distribution of Pandemic-Related Factors

During the 1st survey round, most pandemic-related factors negatively associated with diet quality were present in a minority of the sample (≤15%). Only eating more due to anxiety, depression, or boredom was reported by 47% of the sample (**Table 3**). By the 2nd round (weighted to maintain comparability with 1st round), more participants reported consuming food prepared away-from-home, going out to work ≥4 times/week, and having decreased time for cooking; whereas less participants were using a combination of in-store and home delivery for their grocery shopping. However, more participants were interested in eating healthy, and less participants reported eating more due to anxiety, depression or boredom, and stockpiling junk food. By sociodemographic factors during the 1st survey round, in general we found that the factors negatively associated with dietary quality were more frequent (and the factors positively associated less frequent) among males, younger individuals, those with low SES, and those with low healthy food consciousness. Nonetheless, the opposite was true for eating more due to anxiety, depression or boredom, which was more frequent among females. In addition, having more time for cooking and increased interest in eating healthy was more frequent among younger

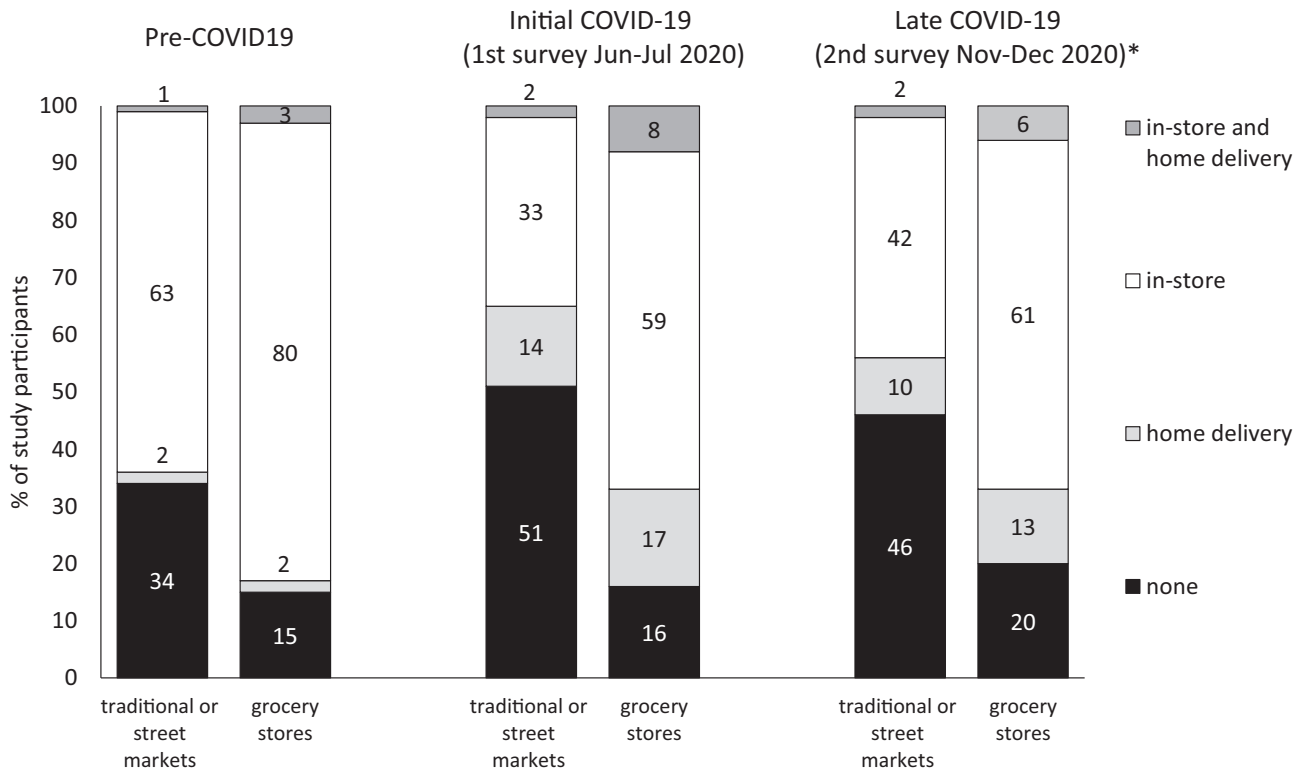

FIGURE 2 | Food shopping place and modality pre-COVID 19 and during initial and later stages of COVID-19 pandemic (1st and 2nd survey round). *Weighted to maintain the distribution of sociodemographic variables of 1st round's participants.

people, while stockpiling junk food was more frequent among those with low SES (**Table 3**).

Changes in self-reported food purchasing patterns were observed from the time before the pandemic to the time of the survey. During the initial stages of the pandemic, for grocery stores purchases, 20% of participants switched from in-store-only to home-delivery options, maintaining the total proportion purchasing from grocery stores at ∼85%. For traditional or street markets purchases, 13% switched to home-delivery options, but the total proportion purchasing from these places decreased from 66 to 49%. During the 2nd survey round (weighted to maintain comparability with 1st round), participants started to return to pre-COVID-19 patterns (**Figure 2**).

DISCUSSION

In these online surveys of Mexican adults carried out during initial (Jun–Jul) and later (Nov–Dec) stages of the COVID-19 pandemic, we found that the majority of the sample perceived that their dietary habits either did not change or improved. Many pandemic-related factors were associated with dietary quality. For instance, eating food prepared away-from-home, going out to work ≥4 times/week, decreased time for cooking, decreased interest in healthy eating, eating more due to anxiety, depression or boredom, food insecurity, and stockpiling junk food, were all negatively associated with diet quality. On the other hand, purchasing food using a combined modality of in-store and home delivery was positively associated with diet quality. The frequency in which the majority of these factors was reported was low, but its frequency was higher in some segments of the population, most notably among those who were younger, from low SES, and who had less healthy food consciousness (those that seldom chose their food based on their nutritional value). Furthermore, dietary quality remained similar between the 1st and 2nd survey rounds, likely because from initial to late lockdown, the frequency of several negative factors increased (consuming food prepared away-from-home, going out to work ≥4 times/week, and having less time to prepare food), but it was compensated by other changes. For instance, from initial to late lockdown, there was an increase in participants interested in eating healthy, and a decrease in participants who reported eating more due to anxiety, depression or boredom, and stockpiling junk food.

Worldwide, several studies have been conducted to understand the effect of the COVID-19 pandemic on dietary habits. Study designs range from online surveys such as our own, to pre-established cohorts with pre-pandemic and pandemic measures, and analysis of sales trends. For online surveys, sample size ranged from ∼400 to ∼3,500 participants. Studies from Latin America and Europe consistently reported that there was an increase (measured or self-perceived) in the intake of legumes (15, 20, 31). Many studies reported an increase in

fruits and vegetables (20, 31–36), with few studies finding a decrease (17, 37). Results were mixed for snacks/sweets, with some studies reporting a decrease (15, 37), and others an increase (16, 31, 33, 38). Likewise, in most studies, including ours, a higher proportion of adults perceived that their diet quality improved rather than worsened (15, 17, 19, 35), with one study reporting the contrary (18). Interestingly, we found that 36% perceived they have gained weight during the pandemic. In three studies from the Middle East and Europe and in our study, the proportion of subjects who perceived weight gain during the pandemic was 30–48%, consistently higher than the proportion that perceived losing weight (14–25%) (15, 39, 40). These findings on weight change might be related to lower levels of physical activity and/or to eating more due to anxiety, depression, or boredom, which was reported by almost half of participants (47%). Overall, the evidence suggests that the pandemic had more positive than negative effects on the diets of those surveyed. However, this was not homogenously observed for all segments of the population. Individual characteristics as well as the particular experience and situation each individual faced during lockdown (e.g., presence or absence of pandemic-related factors) likely played a role in determining the overall effect of the lockdown on dietary intake.

Home confinement in itself and some closely related factors such as not eating food prepared away-from-home and spending more time cooking were positively associated with dietary quality in our study. Furthermore, the effect of home confinement was independent from the effect of eating food prepared away-from-home (e.g., mutually adjusted in Model 2). A previous analysis from the Mexican National Nutrition Survey found that the intake of sweetened beverages and discretionary junk food is lower at home (41). It is possible that homemade food is healthier, but also there might be less exposure to the widespread availability and opportunities to consume unhealthy food found away from home and in social interactions. Studies from other countries coincide in that during lockdown, home-cooking and the intake of homemade food increased, whereas the intake of fast-food or food from restaurants decreased (15, 31, 35, 37, 40, 42, 43). Also, other studies coincide in that spending more time at home was associated with healthier eating, particularly among those that used to have many meals/day away-from home (34, 38). Interestingly, we found that having more free time was not associated with dietary quality. This suggests that convenience might be a less important driver of unhealthy eating as opposed to the widespread availability of junk food outside the home.

Among our sample, food purchase patterns were also affected by the pandemic. We found that online food purchases increased; this was also reported in France, Brazil, and Morocco (17, 36, 43). Online food purchases can have a beneficial impact, since the shopper is not exposed to all of the store's marketing strategies, food cravings are reduced by not seeing the real food, and there is no immediate gratification (44). Remarkably, in our study, better diet quality was found among those that combined in-store with online shopping. One possibility is the bulk of their shopping was made online and that due to biosecurity measures, the in-store purchases were fast and limited to fresh produce (which are harder to order/select online). Thus, ensuring a supply of healthy produce while reducing the exposure to cravings and marketing strategies in the store. Furthermore, we found that despite the migration to home delivery options, the net proportion of participants that purchased from traditional and street markets decreased during the lockdown. Given that traditional/street markets sell mainly fresh produce, it was expected that not purchasing food from these places would have a negative effect on dietary intake. Several reasons such as markets closing, fear of becoming infected with the SARS-COV2 virus while shopping (due to the crowds, lack of safety measures or the need to interact with many buyers), or limited online or home delivery options, might explain the drop in the purchases from traditional/street markets (45). Also related to food purchases, fear of scarcity could lead to stockpiling of food. We found that few people (<15%) perceived food shortages during the 1st survey round (data not shown), yet 40% of the sample stockpiled food (33% basic food and 7% junk food). As anticipated, stockpiling junk food was associated with lower dietary quality. Interestingly, by the 2nd survey round, we found that all food purchases patterns mentioned above were returning to pre-COVID-19 levels.

The pandemic put a strain on the population's mental health, resulting from fear of becoming infected, uncertain situations, economic difficulties, and/or isolation. These negative feelings can trigger emotional eating as a coping mechanism (46). We found that almost half of the sample reported that they were eating more due to anxiety, depression, or boredom; but the proportion was much lower among males (38%) and older subjects (28%), and higher among those with lower SES (58%). Di Renzo et al. reported that in an Italian sample 61% had a depressed mood, 70% had anxious feelings, and 55% felt the need to increase food intake to feel better; and consistent with our study, females were more affected (46). On the flip side, given that this is a sanitary crisis, the population can become more aware of their health status and be motivated to improve their lifestyle habits. We found that half of the sample was more interested in healthy eating. Among Polish adolescents, health and weight control became more important determinants of food choice during lockdown (47).

Overall, we found that pandemic-related factors negatively associated with dietary quality were infrequent in our sample. This might explain why the majority perceived improvements or no changes in the healthiness of their intake during the lockdown. However, we found that there were important differences in the frequency of these negative factors by characteristics such as age, sex, and SES. Many negative factors were more frequent among low SES. For instance, food insecurity (skipping meals, eating less, or not eating in an entire day due to economic constraints) affected 4 to 7% of those in high and middle SES stratums (A/B to C-), yet it reached 26% among those with low SES (D+ and D). Consistent with our findings, according to another survey in Mexico conducted via telephone and with probabilistic sampling, food insecurity was experienced by 26% of those in the D+ stratum. However, this study captured even lower SES (E stratum) and it was reported that 50% experienced food insecurity (23). Also of interest was that most pandemic-related factors negatively associated with diet quality were more common among those that are less healthy food conscious. Likely, this is related to other associated sociodemographic

factors, but it is also possible that being healthy food conscious can have a role in protecting individuals from factors that negatively impact dietary intake. For example, going out to work or not is not up to the individual, but it is also possible that individuals that are more concerned about health issues more actively seek remote working options; or food insecurity might be lower among individuals who, despite economic constraints, place a higher value on nutrition. More research is needed to understand if this is the case.

A key question is whether the pandemic will have a long-lasting effect on the factors observed, or if these will be reestablished once the pandemic subsides. In our 2nd round, many factors were changing in the expected direction. As mobility increased, it also increased the frequency of eating food prepared away-from-home, going out to work, and having less time for food preparation, while the frequency of stockpiling junk food decreased. Interestingly, we found that in comparison to initial (Jun–Jul) lockdown, during the later stage of the pandemic (Nov–Dec), the interest in eating healthy increased and eating more due to anxiety, depression or boredom decreased. The number of cases per day related to COVID-19 were 39% higher during the 2nd round (48). It is possible that by this time, the participants themselves or their close-ones had been infected, which raised awareness of participant's own health status. It could also be the case that there was less isolation and uncertainty surrounding the pandemic, which also decreased the urge to eat due anxiety, depression, or boredom. Future studies will be needed to identify the long-term effects.

Several limitations and strengths to this study must be considered. Because this was a web-based survey, respondents were predominantly from a high income and education background. Another limitation is that the reliability and the level of detail of the data obtained through online surveys are much lower relative to off-line survey methods (49). A strength of our survey is that it went beyond the measurement of current diet quality and self-perceived changes. We also identified a range of pandemic-related factors, which allowed for a better understanding of the drivers of dietary quality during this challenging time. Another strength was the collection of two survey rounds to identify differences over time. Follow-up of the same participants was very limited, but weighing the analysis was useful to obtain more comparable samples. In **Supplementary Table 5** we present results with the subsample in which participation in both surveys was confirmed and results were similar.

The COVID-19 pandemic presents an unprecedented challenge to individuals and society. Amidst the negative impact, the abrupt disruptions in lifestyle can come with certain positive effects for the high and middle SES population. The majority of the sample perceived that their dietary intake either improved or remained unchanged both at initial and later stages of the pandemic. Some factors associated with better diet quality were the home confinement, not consuming food prepared away-from-home, having more time for cooking, purchasing food both in-store and home delivery, and an increased interest in eating healthy. Nonetheless, the pandemic could have also exacerbated negative factors such as eating more due to anxiety, depression or boredom, food insecurity, and the stockpiling of junk food. Hence, a segment of the sample perceived that their dietary intake was unhealthier since the start of the pandemic. Studies like ours are relevant for understanding how the pandemic and other day-to-day factors affected by the pandemic could influence dietary quality. The pandemic might provide new ways of approaching and prioritizing food intake in the long-run. We found that as the pandemic went on, home confinement and home-prepared meals started to decrease but other factors such as the interest in eating healthy increased. Future studies will be needed to understand the long-term impact of the pandemic, if any, on the population's dietary quality.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Research and Ethics Committees of the National Institute of Public Health (INSP). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

CB, LI, and AB conceptualized the survey design. CB, LI, TA, SR-R, DS, and AB developed the survey questionnaire. CB conceptualized the study design, aims and interpreted the data. CB, AC-G, and TA performed the statistical analysis. CB and LI drafted the first version of the manuscript. AC-G, TA, SR-R, DS, and AB revised the manuscript. All authors read and approved the final manuscript.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fnut.2021.758661/full#supplementary-material

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Changes in Food Purchasing Practices of French Households During the First COVID-19 Lockdown and Associated Individual and Environmental Factors

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Background: To limit the spread of COVID-19, a strict lockdown was imposed in France between March and May 2020. Mobility limitations and closure of non-essential public places (restaurants, open-air markets, etc.) affected peoples' food environment (FE) and thus their food purchasing practices (FPPs). This study aimed to explore changes in FPPs of French households during lockdown and associations with individual and environmental factors.

Methods: In April of 2020 households from the Mont'Panier cross-sectional study (n = 306), a quota sampling survey conducted in the south of France, were asked to complete an online questionnaire about their FPPs during lockdown and related factors, including perceived FE (distance to closest general food store, perception of increased food prices, etc.). Objective FE (presence, number, proximity, and density of food outlets) was assessed around participant's home using a geographical information system. Multiple correspondence analysis based on changes in frequency of use and quantity of food purchased by food outlet, followed by a hierarchical cluster analysis, resulted in the identification of clusters. Logistic regression models were performed to assess associations between identified clusters and household's sociodemographic characteristics, perceived, and objective FE.

Results: Five clusters were identified. Cluster "Supermarket" (38% of the total sample), in which households reduced frequency of trips, but increased quantity bought in supermarkets during lockdown, was associated with lower incomes and the perception of increased food prices. Cluster "E-supermarket" (12%), in which households increased online food shopping with pickup at supermarket, was associated with higher incomes. Cluster "Diversified" (22%), made up of households who reduced frequency of

trips to diverse food outlet types, was associated with the perception of increased food prices. Cluster "Organic Food Store" (20%), in which households did not change frequency of trips, nor quantity purchased in organic food stores, was associated with being older (35–50 y vs. <35 y). Finally, cluster "Producer" (8%), which includes households who regularly purchased food from producers, but mostly reduced these purchases during lockdown, was associated with the presence of an organic food store within a 1-km walking distance around home.

Conclusion: This study highlighted diverse changes in FPPs during lockdown and overall more significant associations with perceived than with objective FE indicators.

Keywords: COVID-19 lockdown, food purchasing behaviors, grocery shopping, food outlets, food environment, France

INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic induced lockdowns in several parts of the world, which include France, where governmental authorities imposed a strict lockdown between March 17 and May 10 to slow down and contain the spread of the virus. During this lockdown, the French population was not allowed to leave home except for essential activities such as grocery shopping, medical appointments, legal obligations, and physical activity practices of short duration in the vicinity of home. All non-essential public places and businesses were temporarily closed, which constrained a large part of the working population to work from home or to be temporarily unemployed (partial/technical unemployment). The pandemic's economic impact was thus two-sided, with on one side income drops and on the other side increased savings due to decreased spending on cultural or leisure activities. These shifts in purchasing power, along with other consequences of the pandemic, such as mobility limitations and closure of restaurants, takeaways, canteens, and open-air markets suddenly disrupted people's daily routines, which includes their food shopping habits.

This unprecedented situation stimulated the interest of researchers in the influence of COVID-19 lockdowns on food habits. Changes toward healthier and changes toward less healthy eating behaviors were found in studies conducted worldwide (1). In Europe changes included increased fruit and/or vegetable (FV) consumption (2, 3) and more home-cooked meals (3, 4). Meanwhile, snacking (2, 5) and increased consumption of comfort foods (e.g., energy dense, ultra-processed, sweet and savory foods, alcohol) (5–7) were found to be part of the consequences of the lockdown. Both unhealthy and healthy changes in dietary habits during the lockdown were also found in multiple studies conducted in France (8–12).

Changes in food purchasing behaviors were also studied, but to a lesser extent. Panic buying and stockpiling of food products were observed in many parts of the world (13). Reduced grocery shopping frequency, increased online shopping, and increased purchasing of foods with longer shelf life, such as dried, canned, and frozen foods, were the most common observed changes (14–16). Less is known about consumer's choice of food outlet type during lockdown. The International Agricultural Trade Research Consortium (IATRC) stated that supermarket sales went up at the costs of other retail outlets as shopping trips were less frequent and individual consumers concentrated most purchases on one shop (17). In France, most frequented food outlets during the lockdown were supermarkets and bakeries, with however decreased frequency of use during the lockdown; meanwhile, internet-, phone-, or mail-ordered purchases increased, and frequency of use of local open-air markets reduced drastically due to their closure during the lockdown in cities with more than 20, 000 inhabitants (8). Meanwhile, short food supply chains appear to have been reassuring citizens during the COVID-19 crisis by promoting food sovereignty and increasing food security (18, 19).

The lockdown most likely influenced people unevenly across France according to location (population density, number of COVID-19 cases), but also according to the socioeconomic level of regions. Pullano et al. assessed the effect of demographic and socioeconomic factors during the lockdown in France and reported stronger mobility drops in highly affected regions, but moderate associations with the socioeconomic level of regions (20).

Given the closure of away-from-home food services (restaurants, fast-foods, takeaways, canteens, etc.) and open-air markets, COVID-19 lockdown further changed people's built food environment (FE), which can be defined as the physical distribution of food sources (objective FE). The perceived FE, which is alternatively characterized as consumer's experience of the FE, including in-store experience, was likewise altered during the lockdown due to the variability of food prices (21) and consumer's perceived changes in produce availability (22, 23). Mobility restrictions constraining people to stay in a given perimeter around their home probably nudged consumers to use food outlets in their living area. Consequently, changes in food shopping practices during lockdown might be associated with the FE around people's home. To our knowledge, no prior study has investigated the associations between changes in food purchasing practices (FPPs) and/or objective FE.

Accordingly, we aimed to explore changes in FPPs of southern French households during the first COVID-19 lockdown and assess the associations between these changes and related individual and environmental factors. To do so, we identified clusters based on changes in the organization of grocery

shopping practices, namely frequency of use and quantity of food purchased by food supply source. Then, we investigated the associations between clusters and households' socioeconomic and demographic characteristics and also environmental factors, such as the perceived and the objective FE.

METHODS

Study Population

In April of 2020, participants of the Mont'Panier cross-sectional study were asked to complete an online questionnaire about their FPPs and other related factors during the first COVID-19 lockdown. Briefly, the Mont'Panier study (https://www.etude-montpanier.com) was carried out from May 2018 to December 2019 among households living in the south of France. To be included in the Mont'Panier study, participants had to be 18 or older and live in the Montpellier Metropolitan Area (MMA). Using sociodemographic data of the MMA from the French National Institute of Statistics (INSEE), quota sampling was performed based on household composition (one adult, multiple adults, one adult with at least one child, and multiple adults with at least one child) crossed with age of household head (<30, 30–50, and > 50 years). This study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures were approved by the Institutional Review Board of the French Institute for Health and Medical Research (IRB Inserm n° IRB00003888 IORG0003254 FWA00005831) and were registered to the Commission Nationale Informatique et Libertés. Written electronic informed consent to participate in the study was obtained after a thorough explanation of the study to each of the participants. Participants received a 15 € voucher for returning all data collection materials duly completed.

Lockdown Questionnaire

Participants filled in the COVID-19 lockdown specific online questionnaire, which was launched in April 2020 and included multiple questions on changes in FPPs and related factors. Changes in frequency of use of food supply sources and quantity of food purchased by food outlet were assessed, as were the reasons for these changes. Food supply sources that were considered included supermarkets, e-supermarkets (online food purchasing with pickup at supermarket, called *drives* in French), markets (open-air and closed), organic food stores, greengrocers, other specialized food stores (bakeries, butcher's, fishmonger's, dairy stores etc.), small grocery stores, discount food stores, frozen food stores, and direct sales from producers (basket orders with home delivery or pickup at the farm or drop-off-location). Producers include FV growers (called *maraîchers* in French), farmers and Associations for the Maintenance of Peasant Agriculture (AMAP), which is a French version of Community Supported Agriculture (CSA).

Covariates

Socioeconomic and demographic characteristics were obtained through the online questionnaire of the Mont'Panier study (May 2018 to December 2019) and through the COVID-19 lockdown specific questionnaire (April 2020). Income per unit of consumption (quartiles of the MMA: <980, 980–1,722, 1,723–2,550, and >2,550 €/month), household head's age group (<35, 35–50, >50 years), and level of education (high school degree or lower, undergraduate degree, and postgraduate degree) were obtained through the online questionnaire of the Mont'Panier study. Meanwhile, household composition (one adult, multiple adults, one adult with at least one child, and multiple adults with at least one child) and reported drop of income during lockdown were obtained from the COVID-19 lockdown-specific questionnaire. Median income, by IRIS ("Aggregated unit for Statistical Information") for households living in the cities of Montpellier, Lattes, Juvignac, Castelnau-le-Lez, and Mauguio or by municipality for households living in other cities of the MMA, was used to take into account neighborhood income level. French IRIS areas are the preferred fundamental administrative unit, used by the French national institute for statistics and economic studies (INSEE) for the dissemination of infracommunal data.

Household's food purchases, which were assessed in the Mont'Panier study over a 1-month period using food supply diaries and grocery receipts, allowed us to calculate share of expenses by food supply source before lockdown.

Perceived and Objective Food Environment

The perceived FE was assessed using questions from the lockdown specific online questionnaire, namely perceived walking distance to the closest general food store from home and perceived variability of food prices. Reasons for changes in FPPs declared in the questionnaire were also used as perceived FE variables, namely, buying local products, in-store availability of food products, and store accessibility (closure, public transportation, and parking facilities, etc.).

The objective FE was assessed around participants' home, using the localization of food outlets in the study area and participants' home addresses. Participants' home addresses were obtained through the online questionnaire of the Mont'Panier study, and the localization of food stores in the study area was obtained through the national identification system for natural and legal persons and their establishments (SIRENE) database from INSEE. The SIRENE database was completed, corrected, and verified using: (i) OpenStreetMaps, which provides open data of companies and establishments, through a collaborative project in which external contributors can update and enrich the database, (ii) online searches on Google Maps, company websites of major food retailers, and city websites (e.g., with information on local markets), and (iii) field observations of about 10% of the studied area.

Classification of food outlet types was done based on the initial classification of food stores of the SIRENE database. In this study, we focused on multiple types of food outlets: supermarkets, markets (open-air markets and covered markets), greengrocers, bakeries, other specialized food stores (butcher's, fishmonger's, and dairy stores), organic food stores, and small grocery stores.

Geographical information systems were performed to calculate FE indicators around participants' home using QGIS (version 3.4.7.). Four types of indicators estimated the objective FE around participants' home: number, presence, proximity, and relative density. The proximity of food stores was calculated

by assessing the shortest road network distance between the nearest food outlet relative to each home address. The number of each food outlet type was calculated within a 1,000-m road network buffer around each home address. A 1,000-m buffer was chosen since the French population had to stay within a 1 km radius of their home during the lockdown except for essential activities. The number of food outlets was used to calculate the presence (binary count) and the relative density of food stores (e.g., relative density of food stores selling FV = number of food outlets selling FV/the total number of food outlets). A number of food outlet variables were categorized into three groups for main analysis given their non-normal distribution.

Statistical Analysis

Descriptive statistics were expressed as percentages and means (standard deviation). Differences between clusters were assessed by Pearson's chi-square tests for categorical variable and Wilcoxon tests for numerical variables.

To identify different patterns of change of FPPs during lockdown, we used a two-step procedure. First, a multiple correspondence analysis (MCA) was applied on changes in frequency of use of food supply sources and changes in quantity of food purchased by food outlet type. Inertia, that is, the variance in individual patterns around the average pattern, is measured. MCA decomposes the inertia by identifying a small number of mutually independent dimensions (24). Dimensions are formed by identifying the axes for which the distance between the patterns and axes is minimized, while simultaneously maximizing the amount of explained inertia. Each dimension has an eigenvalue, and the ratio of the eigenvalue for one dimension represents the proportion of the total inertia explained by that dimension. The number of retained dimensions is chosen using Kaiser Criterion, to obtain a cumulative percentage of acceptable variance (25). Using the dimensions retained, a clustering procedure was then performed by applying Ward's hierarchical classification of the individuals, followed by K-means clustering, maximizing the interclass inertia. The graphical observation of the dendrogram, which illustrates stages of classification, was used to estimate the appropriate number of clusters (26). Stabilization of the clusters was carried out to distribute the individuals better by clusters. Cluster analysis yielded groups, interpreted as patterns of changes in the organization of FPPs, labeled according to their frequency of use and quantity of food purchased by food outlet.

Logistic regression models were performed by calculating odds ratios (ORs) and 95% confidence intervals (CIs) to determine the strength of the associations between each cluster membership (belonging to this cluster vs. not) and each explanatory variable, that is, socioeconomic and demographic characteristics, and also perceived and objective FE variables. The equation of the logistic regression models was as follows: $Y = \beta_0 + \beta_1 X_1 + \ldots + \beta_p X_p$, where Y = binary variable for belonging to cluster X (0/1), β_0 = intercept, X_{1-p} = individual and environmental variables and β_{1-p} = coefficients for the corresponding variables. Only explanatory variables associated with clusters at 0.1 significance level in bivariate analyses were retained for inclusion in the subsequent multivariate models. Subsequently, multivariable backwards-stepwise logistic regression was performed to determine the variables included in the final model, with income per unit of consumption, household composition, age, and educational level of household head forced into the model. Variables whose exclusion from the model caused large fluctuations in OR (>10%), and also variables whose exclusion increased the significance of the likelihood ratio tests ($p > 0.05$), were re-entered into the model.

Analyses were conducted on a weighted sample where weights were calculated by raking ratio so that the marginal distribution of the weighted sample conforms to the marginal distribution of the targeted population. Data on socioeconomic and demographic characteristics of the MMA were obtained from the INSEE database of 2017. The sample was adjusted by calibration on margins based on income per unit of consumption and household composition crossed with household head's age group. All analyses presented in this paper were conducted on the weighted sample.

Statistical analyses were performed using R Statistical Software (version 4.1.0), and the threshold for statistical significance was $p < 0.05$.

RESULTS

Analyses were carried out on 306 households residing in the MMA, who had previously participated in the Mont'Panier study (May 2018 to December 2019), responded to the lockdown specific online questionnaire (April 2020) and did not change place of residence during the lockdown.

Given the sample's adjustment by calibration on margins based on socioeconomic and demographic characteristics of the MMA population, distributions correspond to those of the real population. These results are presented in the first column of **Table 1**. Two-thirds of households were households without children, composed of a single adult or multiple adults, quartiles of income per unit of consumption were 980, 980–1,722, 1,723–2,550, and 2,551 €/month, nearly half of household heads were over 50 years old, and most household head had an educational level higher than high school degree.

Changes in Food Purchasing Practices During the Lockdown

Changes in the frequency of use of food supply sources and quantity of food purchased by food supply source during lockdown are regrouped in **Figure 1**. Nearly half of the weighted sample reduced their frequency of use of supermarkets and one-third increased quantity of food purchased in supermarkets. Online grocery shopping with pickup at supermarket increased in frequency of use and also in quantity purchased for about one in 10 households. Increased frequency of purchases from producers was found for about two in 10 households. Mostly decreased frequency of visits and also decreased quantity of food purchased were observed for other food outlet types, with the exception of greengrocers, where an increase in quantity of food purchased occurred for about one-fourth of households.

TABLE 1 | Households' socioeconomic and demographic characteristics.

	Total sample[a]	Cluster Supermarket 38%	Cluster E-supermarket[b] 12%	Cluster Producer[c] 8%	Cluster Organic Food Store 20%	Cluster Diversified 22%	Pearson's X^2 *p*-value
Household composition							**0.011**
One adult	**43.8%**	**52.2%**	36.3%	21.9%	**41.3%**	**43.4%**	
Multiple adults	22.8%	22.9%	15.6%	22.4%	29.4%	20.9%	
One adult with at least one child	11.9%	13.7%	0.0%	**34.2%**	10.0%	9.3%	
Multiple adults with at least one child	21.5%	11.3%	**48.1%**	21.6%	19.4%	26.4%	
Income per consumption unit							**0.016**
<980 €/month	25.0%	**38.1%**	9.5%	**31.1%**	11.1%	21.4%	
980–1,722 €/month	25.0%	25.9%	**42.9%**	28.9%	19.2%	17.1%	
1,723–2,550 €/month	25.0%	21.7%	22.7%	15.8%	32.5%	28.6%	
≥2,551 €/month	25.0%	14.3%	25.0%	24.3%	**37.3%**	**32.9%**	
Age of household head							0.279
<35 years	28.7%	36.7%	25.5%	31.8%	13.7%	28.7%	
35–50 years	26.5%	18.7%	**41.2%**	23.2%	32.0%	28.0%	
>50 years	**44.9%**	**44.6%**	33.4%	**45.0%**	**54.3%**	**43.3%**	
Level of education of household head							0.055
High school degree or lower	13.8%	17.9%	13.4%	2.1%	10.9%	13.5%	
Undergraduate degree	42.7%	**49.9%**	**44.6%**	**60.2%**	38.7%	26.5%	
Postgraduate degree	**43.5%**	32.2%	42.0%	37.7%	**50.4%**	**60.1%**	

[a] *The sample was adjusted by calibration on margins based on income per unit of consumption and household composition crossed with household head's age group.*
[b] *E-supermarket: Online food shopping with pickup at supermarket (called drive in French).*
[c] *Producer: direct sales from producers [e.g., fruit and vegetable growers (called maraîchers in French), farmers, basket orders from Associations for the Maintenance of Peasant Agriculture (AMAP), which is a French version of Community Supported Agriculture].*
The numbers in bold represent the highest percentages among each cluster for each variable.

It should be noted that percentages presented as "more" for frequency of use and also include households who reported using the respective food supply sources only since the lockdown. For instance, among the households that reported increased frequency of use of e-supermarkets, half (5%) were new users of e-supermarkets. Likewise, 6.5% of households reported being new users of supermarkets and hard-discount stores combined. We also observed 0.5% of new users of organic food stores and 8.5% for producers.

Supplementary Table 1 presents description of main reasons for change in FPPs during lockdown, perceived FE, and other related factors for the total weighted sample (column 1). Results by cluster will not be described here to avoid redundancy, but are available in columns 2–6 of **Supplementary Table 1**.

Main Reasons for Change in Food Purchasing Practices During Lockdown

Main reasons for change in FPPs during lockdown were "limiting exposure to the COVID-19 virus" (66.4%) and to a lesser extent "changes in cooking and consumption" (34.1%), "distance to food store" (31.1%), "in-store availability of food products" (29.7%), "store accessibility" (29.4%), and "buying local products" (27.8%) (**Supplementary Table 1**).

Perceived Food Environment

Walking distance from home to the closest general food store was under 15 min for 70% of the weighted study sample and 11% reported needing more than 30 min to get to the closest general food store. One-third of the weighted study sample perceived a rise in food prices during the lockdown, whereas nearly half of the sample reported not knowing whether prices of food products increased or not (**Supplementary Table 1**).

Other Related Factors

Half of households of the weighted study sample reported increased grocery expenses, more than two-thirds of households reported no stockpiling of food products and 72% reported a drop of household income during lockdown (**Supplementary Table 1**).

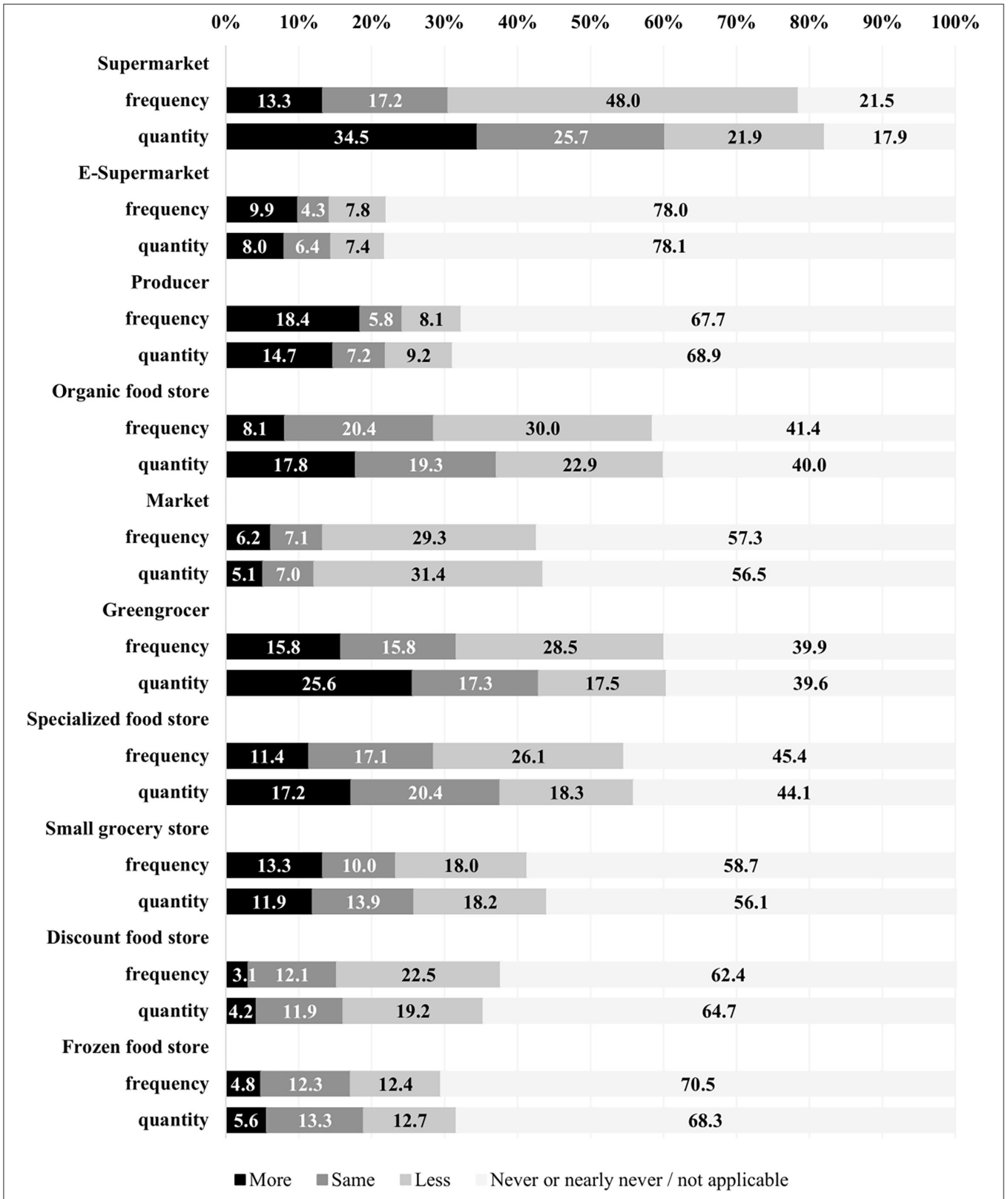

FIGURE 1 | Changes in frequency of use and quantity purchased by food supply source during lockdown. E-supermarket: online food shopping with pickup at supermarket (called drive in French). Producer: direct sales from producers [e.g., fruit and vegetable growers (called maraîchers in French), farmers, basket orders from Associations for the Maintenance of Peasant Agriculture (AMAP), which is a French version of Community Supported Agriculture]. Specialized food store: bakeries, butcher's, fishmonger's, and dairy stores.

TABLE 2 | Mean share of expenses before lockdown by food supply source for each cluster.

	Cluster Supermarket 38%	Cluster E-supermarket[a] 12%	Cluster Producer[b] 8%	Cluster Organic Food Store 20%	Cluster Diversified 22%	Wilcoxon/ Mann-Whitney *p*-value
Supermarket	**56.02 (4.03)**	**57.28 (5.81)**	**46.38 (8.96)**	**43.87 (3.10)**	**46.06 (2.96)**	0.063
Discount food store	**19.08 (3.43)**	**14.15 (7.75)**	2.23 (1.75)	3.39 (0.80)	5.87 (1.34)	**<0.001**
Small grocery store	6.68 (2.41)	8.63 (3.25)	**10.00 (4.65)**	8.83 (2.05)	8.62 (2.03)	0.064
Producer[b]	1.12 (0.26)	1.42 (0.55)	**10.24 (4.91)**	3.63 (1.19)	3.16 (0.80)	0.138
Organic food store	3.23 (0.98)	2.61 (0.80)	**10.77 (6.77)**	**11.81 (2.25)**	5.74 (1.12)	**<0.001**
Specialized food stores[c]	7.45 (1.58)	8.42 (1.41)	**10.39 (4.08)**	**14.25 (2.34)**	**14.63 (2.23)**	**0.001**
Market	3.15 (0.71)	2.33 (0.58)	6.74 (2.60)	7.97 (1.57)	**11.38 (2.08)**	**<0.001**
Frozen food store	1.32 (0.33)	2.11 (0.77)	0.66 (0.38)	2.77 (0.70)	2.43 (0.53)	**0.023**
Online purchasing	0.57 (0.21)	1.59 (0.61)	0.77 (0.47)	0.88 (0.42)	0.91 (0.46)	0.430
Other	0.09 (0.04)	0.20 (0.11)	0.01 (0.01)	0.78 (0.42)	0.20 (0.07)	**<0.001**

Share of expenses were calculated using till receipts collected during 1 month in the Mont'Panier study.

[a] *E-supermarket: Online food shopping with pickup at supermarket (called drive in French).*

[b] *Producer: direct sales from producers [e.g., fruit and vegetable growers (called maraîchers in French), farmers, basket orders from Associations for the Maintenance of Peasant Agriculture (AMAP), which is a French version of Community Supported Agriculture].*

[c] *Specialized food stores: greengrocers, bakeries, butcher's, fishmonger's, and dairy stores.*

The numbers in bold represent the means among each cluster that were >10% or p-values <0.05 for the last column.

Clusters of Change of Food Purchasing Practices During Lockdown

Five clusters were identified and interpreted as changes in FPPs as "*Supermarket*," "*E-supermarket*," "*Producer*," "*Organic food store*," and "*Diversified*," representing, respectively 38, 12, 8, 20, and 22% of households of the total sample.

Table 1 presents socioeconomic and demographic characteristics of households for each cluster (columns 2–6), and **Table 2** presents mean share of expenses before lockdown by food supply source for each cluster. Changes in frequency of use and quantity of food purchased by food supply source for each cluster are represented in **Supplementary Table 2**.

Cluster "*Supermarket*" was composed of households who did most of their grocery shopping in supermarkets, but reduced trips to, and increased quantity of food purchased in supermarkets during lockdown. Half of households of this cluster were composed of single adults, more than one-third of households were in the lowest income group (<980 €/month), and nearly half of household heads were over 50 years old and had an undergraduate degree. Mean share of expenses before lockdown was highest for supermarkets and discount grocery stores.

Cluster "*E-supermarket*" was composed of households who increased in frequency and in quantity purchased their use of online food shopping with pickup at supermarket. Very few households of this cluster reported never having used e-supermarkets before the lockdown. This cluster is mostly composed of households with multiple adults and at least one child, household of middle-low income (980–1,722 €/month) and household heads who were 35–50 years old and had an undergraduate degree. Mean share of expenses before lockdown was here again highest for supermarkets and discount grocery stores.

Cluster "*Producer*" included households who regularly purchased food directly from producers, but mostly reduced these purchases during lockdown. One-third of households of this cluster was composed of one adult with at least one child, had lower income (<980 €/month), nearly half of household heads were above 50 years old, and most had at least an undergraduate degree. Mean share of expenses before lockdown were about 10% for organic food stores, producers, specialized food stores, and small grocery stores; supermarkets had once again the most important share of expenses.

Cluster "*Organic food store*" was mostly composed of organic food store users, who did not change their frequency of use and quantity of food purchased in organic food stores during the lockdown. Most represented households were households composed of one adult, with higher income (>2,551 €/month), older and highly educated household heads (>50 years old and postgraduate degree). Besides supermarkets, most important shares of expenses before lockdown were for specialized food stores and organic food stores.

Cluster "*Diversified*" included households who had diversified food supply sources with reduced frequency of trips to supermarkets, markets, organic food stores, greengrocers and other specialized food stores and reduced quantity of food purchased in markets. This cluster was mostly composed of single adults, with higher income (>2,550 €/month), older and highly educated household heads (>50 years old and postgraduate degree). Most important shares of expenses before lockdown were for supermarkets, specialized food stores, and markets.

TABLE 3 | Associations between clusters and socioeconomic and demographic characteristics, perceived, and objective FE indicators.

	Cluster Supermarket 38%		Cluster E-supermarket[a] 12%		Cluster producer[b] 8%		Cluster organic food store 20%		Cluster diversified 22%	
	OR	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Socioeconomic and demographic characteristics										
Household composition										
One adult	—	—	—	—	—	—	—	—	—	—
Multiple adults	1.00	0.49, 2.07	0.62	0.20, 1.86	**4.30**	**1.02, 18.1**	1.08	0.48, 2.46	0.83	0.36, 1.90
One adult with at least one child	0.53	0.12, 2.34			**24.8**	**3.53, 175**	1.05	0.23, 4.80	1.05	0.27, 4.09
Multiple adults with at least one child	0.43	0.18, 1.03	1.36	0.54, 3.40	**7.47**	**1.25, 44.6**	0.55	0.22, 1.38	1.11	0.47, 2.61
Income per consumption unit										
<980 €/month	—	—	—	—	—	—	—	—	—	—
980–1,722 €/month	0.55	0.22, 1.37	**10.5**	**2.17, 51.2**	0.71	0.17, 2.92	0.94	0.27, 3.30	0.92	0.30, 2.83
1,723–2,550 €/month	0.37	0.12, 1.12	**8.06**	**1.69, 38.6**	0.54	0.12, 2.41	1.70	0.48, 5.97	1.48	0.44, 5.01
≥2,551 €/month	**0.28**	**0.08, 0.90**	**7.95**	**1.70, 37.3**	0.63	0.13, 2.92	1.67	0.47, 5.87	1.37	0.38, 5.03
Age of household head										
<35 years	—	—	—	—	—	—	—	—	—	—
35–50 years	0.61	0.22, 1.69	0.77	0.26, 2.32	0.49	0.07, 3.53	**3.53**	**1.08, 11.5**	0.69	0.24, 1.96
>50 years	0.81	0.34, 1.94	0.45	0.15, 1.34	2.95	0.68, 12.9	2.35	0.81, 6.85	0.55	0.21, 1.45
Level of education of household head										
High school degree or lower	—	—	—	—	—	—	—	—	—	—
Undergraduate degree	0.69	0.27, 1.73	0.68	0.20, 2.35	7.60	0.91, 63.1	1.58	0.52, 4.76	0.63	0.22, 1.78
Postgraduate degree	0.62	0.22, 1.72	0.38	0.10, 1.37	4.53	0.53, 38.3	1.77	0.59, 5.34	1.39	0.49, 3.93
Median income (IRIS or municipality)										
Low			—	—					—	—
Medium-low			0.55	0.18, 1.67					2.07	0.69, 6.17
Medium-high			1.75	0.62, 4.97					0.57	0.16, 1.98
High			0.59	0.21, 1.66					2.30	0.89, 5.96
Perceived food environment										
Distance from home to the closest general food store										
<5 min	—	—	—	—						
Between 5 and 15 min	1.63	0.73, 3.61	1.73	0.77, 3.88						
Between 15 and 30 min	2.68	1.00, 7.18	**0.17**	**0.05, 0.61**						
More than 30 min	**4.74**	**1.32, 17.0**								

(Continued)

TABLE 3 | Continued

	Cluster Supermarket 38%		Cluster E-supermarket[a] 12%		Cluster producer[b] 8%		Cluster organic food store 20%		Cluster diversified 22%	
	OR	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Perception of increased food prices during the lockdown										
No	—	—			—	—	—	—	—	—
Yes	**2.44**	**1.10, 5.39**			**0.04**	**0.01, 0.35**	**0.16**	**0.07, 0.40**	**3.23**	**1.23, 8.49**
Don't know	1.95	0.89, 4.29			1.17	0.39, 3.46	**0.27**	**0.13, 0.58**	2.14	0.87, 5.28
In-store availability of food products (reason for change[c])										
No			—	—	—	—	—	—		
Yes			**2.91**	**1.33, 6.36**	2.27	0.81, 6.40	**0.42**	**0.18, 0.98**		
Buying local products (reason for change[c])										
No	—	—			—	—			—	—
Yes	**0.30**	**0.15, 0.62**			**0.17**	**0.03, 0.90**			**3.46**	**1.71, 7.02**
Objective food environment										
Presence of an organic food store (1,000 m from home)										
No	—	—			—	—				
Yes	**0.25**	**0.09, 0.72**			**5.46**	**1.86, 16.1**				

Only FE indicators associated with clusters at 0.1 significance level in bivariate analyses were retained for inclusion in multivariate models.

Multivariable backwards-stepwise logistic regression was performed to determine the variables included in the final model, with income per unit of consumption, household structure, age, and educational level of household head forced into the model.

[a] *E-supermarket: Online food shopping with pickup at supermarket (called drive in French).*

[b] *Producer: direct sales from producers [e.g., fruit and vegetable growers (called maraîchers in French), farmers, basket orders from Associations for the Maintenance of Peasant Agriculture (AMAP), which is a French version of Community Supported Agriculture].*

[c] *As a reason for change in FPPs during the lockdown.*

The numbers in bold represent significant results ($p < 0.05$).

Associations Between Cluster Membership and Individual and Environmental Factors

Results of multivariate logistic regression models assessing the associations between clusters of change in FPPs during lockdown and socioeconomic and demographic characteristics, perceived, and objective FE indicators are represented in **Table 3**.

Compared to other clusters, households belonging to the *Cluster* "*Supermarket*" were less likely to have higher incomes, but more likely to live at more than 30 min from a general food store and to perceive a rise in food prices during lockdown. They were also less likely to report "buying local products" as a reason for change in FPPs and to live within a 1-km walking distance from an organic food store.

Households from *Cluster* "*E-Supermarket*" were more likely to have higher incomes, less likely to live at 15 min or more from a general food store and more likely to report "in-store availability of food products" as a reason for change in FPPs.

In *Cluster* "*Producer*" were households who were less likely to be composed of a single adult, to perceive a rise in food prices during lockdown and to report "buying local products" as a reason for change in FPPs; households were however more likely to live within a 1-km walking distance from an organic food store.

Households belonging to *Cluster* "*Organic food store*" were more likely to have an older household head (35–50 vs. < 35 years old), less likely to perceive a rise in food prices during lockdown and to report "in-store availability of food products" as a reason for change in FPPs.

Households from *Cluster* "*Diversified*" were more likely to perceive a rise in food prices during lockdown and to report "buying local products" as a reason for change in FPPs.

Drop of income during lockdown and store accessibility (closure, public transportation, and parking facilities, etc.) as a reason for change in FPPs during lockdown had p-values > 0.1 in bivariate analysis and were thus not included in multivariate models. Not cited socioeconomic and demographic characteristics, perceived FE variables and also most objective FE indicators were not statistically significantly associated with given clusters.

DISCUSSION

By exploring changes in FPPs of French households during the first COVID-19 lockdown and their related individual and environmental factors, our study highlighted diverse grocery shopping practices with a global tendency of reduced frequency of trips to food outlets, but no major change in food outlet choice. Significant associations of these practices with sociodemographic characteristics and perceived FE indicators were also found, rather than with objective FE indicators.

Despite the expected rise in popularity of alternative food supply chains, which were widely covered in the press during the COVID-19 crisis and spontaneously evoked by involved French consumers during the lockdown (19), our study rather suggests a modest increase in new users of alternative food supply sources such as producers and a persistent dominance of the industrial food system, leading with supermarkets, as the main food supply source for consumers.

More precisely, results of our study show that frequency of trips to food stores tends to have globally reduced during the lockdown, with the exception of e-supermarkets (online food shopping with pickup at supermarket), which were more frequently used by households during this period; similar results were found in another French study (8). Likewise, it has been reported elsewhere that during the lockdown, consumers reduced shopping trips and concentrated most food purchases on one shop, and thus, supermarket sales went up at the costs of other retail outlets (17). Frequency of trips has probably been reduced to limit exposure to the COVID-19 virus, which was the most frequently reported reason for changes in food supply sources in our study.

Before the lockdown, households did most of their grocery shopping in supermarkets, and mean share of expenses was highest for supermarkets in all five clusters, but especially for *Clusters* "*Supermarket*" and "*E-supermarket*," in which households spent more than half of their expenses in supermarkets. These two clusters, which include 50% of households of our total sample, differentiated their FPPs during the lockdown by either sticking to supermarkets with reduced frequency of trips and increased quantity purchased, or by increasing their use of online food purchasing with pickup at supermarket. Lower income households seem to have chosen to stick to traditional stationary shopping, whereas higher income households seem to have turned to online food shopping. These results seem coherent, since lower income households are less inclined to make use of e-grocery shopping practices (27), which is not surprising given that ownership of computing equipment with internet access such as smartphones, tablets, laptops, and computers, needed for online purchasing, goes together with higher incomes (28). This brings out some social inequalities regarding food purchasing opportunities for lower income households.

Results of multivariate analysis showed that households of *Cluster* "*Supermarket*," compared to households of other clusters, were more likely to live at more than 30 min from a general food store and to perceive a rise in food prices during lockdown. Living further away from a general food store nudges the consumer to concentrate most food shopping in one place and the supermarket, which offers a variety of food products, allows the consumer to find all he needs at once. Perception of increased food prices is most likely more important for lower income households, since they pay more attention to price fluctuations and a food price inflation due to COVID-19 restrictions has indeed been observed in Europe during the first lockdown period (March to April 2020) (21). *Cluster* "*Supermarket*" was negatively associated with "buying local products" as a reason for change in FPPs. These results are coherent with those of a study conducted in France, which suggest that consumers shopping mainly in supermarkets are less likely to be involved with local food production (29).

Belonging to the *Cluster,* "*E-supermarket*" was associated with reporting "in-store availability of food products" as a reason for changes in FPPs. In-store availability of food produces has been

identified as an issue in a great number of supermarkets during COVID-19 lockdown, mainly due to consumer's stockpiling behavior (22, 23). It is thus not surprising that households who before lockdown used to do most of their grocery shopping in supermarkets turned to online food shopping partly because of lower in-store availability of food products. The advantage of e-supermarkets being that you are aware beforehand of produce availability, which allows you to avoid wasting a trip to the supermarket for nothing.

As opposed to the two above cited clusters, *clusters* "*Diversified*," "*Organic Food Store*," and "*Producer*" had more diversified food-shopping sources. Even though share of expenses before lockdown was also most important for supermarkets, it was of about 10–15% for other food stores, which includes specialized food stores and markets for *cluster* "*Diversified*," specialized food stores and organic food stores for *cluster* "*Organic food store*" and specialized food stores, organic food stores, greengrocers, and small grocery store for *cluster* "*Producer*."

Cluster "*Diversified*" included households who had diversified food supply sources, but who reduced frequency of trips to supermarkets, markets, organic food stores, greengrocers, and other specialized food stores during the lockdown and also reduced quantity of food purchased in markets. Households of this cluster were more likely to report "buying local products" as a reason for change in FPPs. Varying food store types might be a way for the consumer to find local food products produced by small local firms (30). As a matter of fact, greengrocers and other specialized food stores, which include bakeries, butcher's, fishmongers, dairy stores, are settings in which the consumer is able to ask where the food comes from and how it had been produced, as opposed to supermarkets where the staff in contact with consumers has no role in the production or supply of products (29). Moreover, households of this cluster were more likely to perceive a rise in food prices during lockdown. Even though there was no significant association with income level, descriptive analysis showed that 43% of households of this cluster had lower income and were thus probably more prone to perceive price variations.

Cluster "*Organic food store*" is mostly composed of households who had few changes in their FPPs, which were diversified in food supply sources, but more substantial for organic food stores. This cluster included households who were more likely to have an older household head (35–50 vs. <35 years old), less likely to report "in-store availability of food products" as a reason for change in FPPs and less likely to perceive a rise in food prices during lockdown. Likewise, another study also found that those aged 35–44 had a higher probability of consuming organic products (31). Given that stockpiling during lockdown was mostly noted in supermarkets (since they were the most frequented food outlets), in-store availability of food products might not have been as noticeable for consumers who frequented other food store types. Moreover, consumers who prefer organic food products tend to be less price sensitive (32).

Households of *cluster* "*Producer*," who reduced purchases from producers during the lockdown, were more likely to live within a 1-km walking distance from an organic food store. This seems coherent, since two out of three households of this cluster are organic food stores users (only 35.7% reported never using them). One could hypothesize that those households replaced their purchases from producers with purchases from organic food stores, probably because of accessibility issues, which was reported as a reason for change in FPPs for 46.3% of households of this cluster. Additionally, indeed, open air street stands, which are often used by producers to sell their products on the side of the road, were closed during the first lockdown in France. Households of *cluster* "*Producer*" were also less likely to be composed of a single adult, to perceive a rise in food prices during lockdown and to report "buying local products" as a reason for change in FPPs. As stated by another study conducted in France, consumers of less traditional food retailers (as opposed to traditional supermarket users) are less price-sensitive, probably because they are aware of the cost of the production process and may consider price as an indicator of quality (29). In addition, these households were already invested in buying local products before the lockdown; reasons for change in FPPs which involved reducing purchases from producers were thus not to buy local products. It should be noted that being constituted of 8% of households of the total sample, this cluster is the smallest of the five identified clusters of our study sample, and results are thus to be considered with caution.

Drop of income during lockdown and store accessibility (closure, public transportation, and parking facilities, etc.) as a reason for change in FPPs and most objective FE indicators were not statistically significantly associated with any of the five identified clusters of our study. Percentage of households who reported a drop of income during lockdown was relatively well-distributed among the five clusters, the same counts for store accessibility as a reason for change in FPPs. Objective FE, also called community or built FE, often presents less consistent significant relationships with dietary behaviors than perceived FE (33). Indeed, objective FE indicators on their own simply cannot capture non-geographic dimensions of the FE (33), such as in-store availability of food products, food prices, and consumer's preferences.

Strengths and Limitations

The strengths of our study include the timing of the data collection to capture changes during the lockdown, which was launched in April of 2020, so *during* the first COVID-19 related lockdown and not after, thereby limiting memory bias of participants. In addition, comparisons were possible with objectively measured food purchasing behaviors before the lockdown (e.g., share of expenses by food outlet type) due to the original data set of the Mont'Panier study which collected details of households' food supply before the lockdown (May 2018 to December 2019) using food purchase receipts. Another strength is the use of both perceived and objective FE indicators. The importance of combining both perceived and objective FE measures has previously been highlighted in a systematic review (33), where authors point to the fact that studies should not only take into account the geographical aspects of the FE, but also in-store availability of food products, food prices, and consumer's preferences (33).

We acknowledge that there were some limitations to this study. First, caution is needed regarding the extrapolation of these results to the entire French population, since this study was limited to a metropolitan area located in the South of France. Results would most likely be different in a less densely populated urban area or in a rural setting. Moreover, changes in food shopping behaviors and related variables were self-reported, and thus, misreporting may have occurred, however to account (at least at some extent) for this potential bias, comparisons between data collected before and during the lockdown were carried out. For instance, frequency of use of food supply sources before lockdown, obtained through the 1-month collection of receipts in the Mont'Panier study, was compared to the reported changes in frequency of use of food supply sources during the lockdown. Sample size is another limitation of our study, thereby limiting the validity and generalizability of our study's results. Finally, selection bias may also be an issue in this study, since households of this study were mostly highly educated. However, to limit this selection bias, quota sampling was performed based on household composition crossed with age of household head, plus all analyses presented in this paper were conducted on a weighted sample, which was adjusted by calibration on margins based on income per unit of consumption and household composition crossed with household head's age group.

CONCLUSION

In conclusion, this study highlighted diverse changes in FPPs of southern French households during the first COVID-19 lockdown and some associations between these changes and related individual and environmental factors. Overall, our results showed more significant associations with perceived than with objective FE indicators, which highlights the importance of combining both measures when assessing relationships with dietary behaviors. Better understanding FPPs and associated FE characteristics are important, especially now given the exacerbated food retail access concerns that came along with the COVID-19 pandemic.

Despite the expected rise in popularity of short supply chains, the obvious ongoing supremacy of supermarkets in the food retail sector and the shift from stationary to online food shopping highlighted in our study show that there is still room for improvement to create a more sustainable and resilient food system. For future lockdowns, public health policies and city councils should consider strengthening online food purchasing, since they help avoid physical contact and reduce thus the risk of new infections. For more sustainable urban food systems, innovations in safe grocery shopping practices for short supply chains, small food outlets, and local producers should be encouraged by policy makers. Given our findings on social inequalities regarding food purchasing opportunities for low-income populations, special efforts should be made to find new ways to increase safe access to food for those with no internet access and no car. Possible strategies to consider include expanding or implementing food purchases through phone orders, possibility for pedestrian pickup, and free home delivery services.

Urban food planning policies should take into account the diversification of food purchasing opportunities that seem to have occurred during this first lockdown and pay close attention to a potential social fragmentation in FPPs. Beyond the pandemic, results of this study might thus provide useful information for cities looking to improve their FE in the long run.

DATA AVAILABILITY STATEMENT

Restrictions apply due to the protection of health data regulation set by the French National Commission on Informatics and Liberty (Commission Nationale de l'Informatique et des Libertés, CNIL). Requests to access these datasets should be directed to Caroline Méjean, caroline.mejean@inrae.fr.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Institutional Review Board of the French Institute for Health and Medical Research (IRB Inserm n° IRB00003888 IORG0003254 FWA00005831) and were registered to the Commission Nationale Informatique et Libertés. This study was conducted according to the guidelines laid down in the Declaration of Helsinki. The patients/participants provided their written informed consent to participate in this study.

SURFOOD-FOODSCAPES WORKING GROUP

The following authors were part of the Surfood-Foodscapes Working Group: Caroline Mejean, Christophe Soulard, Coline Perrin, Daisy Recchia, Emmanuelle Cheyns, Géraldine Chaboud, Marion Tharrey, Marlène Perignon, Nicolas Bricas, Nicole Darmon, Olivier Lepiller, Pascale Sheromm, Pascaline Rollet, and Simon Vonthron.

AUTHOR CONTRIBUTIONS

CM, MP, and NB designed the study and developed the questionnaire and the protocol for data collection. PR performed data management and undertook data analysis. SV and CP calculated FE indicators. DR wrote the first draft of the manuscript. Surfood-Foodscapes Working Group gave insights on the interpretation of the results. All authors contributed to manuscript revision, read, and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fnut.2022.828550/full#supplementary-material

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Corrigendum: Changes in Food Purchasing Practices of French Households During the First COVID-19 Lockdown and Associated Individual and Environmental Factors

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A Corrigendum on

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In the published article, there was an error regarding the affiliation(s) for "Simon Vonthron and Coline Perrin." Instead of affiliation 2, they should have affiliation 3 "INNOVATION, Univ Montpellier, CIRAD, INRAE, Institut Agro, Montpellier, France."

The authors apologize for this error and state that this does not change the scientific conclusions of the article in any way. The original article has been updated.

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Impacts of the COVID-19 Pandemic on Children's Sugary Drink Consumption: A Qualitative Study

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The coronavirus (COVID-19) pandemic has caused striking alterations to daily life, with important impacts on children's health. Spending more time at home and out of school due to COVID-19 related closures may exacerbate obesogenic behaviors among children, including consumption of sugary drinks (SDs). This qualitative study aimed to investigate effects of the pandemic on children's SD consumption and related dietary behaviors. Children 8–14 years old and their parent (n = 19 dyads) participated in an in-depth qualitative interview. Interviews were recorded, transcribed verbatim, and independently coded by two coders, after which, emergent themes and subthemes were identified and representative quotations selected. Although increases in children's SD and snack intake were almost unanimously reported by both children and their parents, increased frequency of cooking at home and preparation of healthier meals were also described. Key reasons for children's higher SD and snack intake were having unlimited access to SDs and snacks and experiencing boredom while at home. Parents also explained that the pandemic impacted their oversight of the child's SD intake, as many parents described loosening prior restrictions on their child's SD intake and/or allowing their child more autonomy to make their own dietary choices during the pandemic. These results call attention to concerning increases in children's SD and snack intake during the COVID-19 pandemic. Intervention strategies to improve the home food environment, including reducing the availability of SDs and energy-dense snacks and providing education on non-food related coping strategies are needed.

Keywords: sugar-sweetened beverages, coronavirus, diet, youth, obesity, soda, nutrition

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INTRODUCTION

The COVID-19 pandemic has significantly impacted the daily lives of families in the United States (U.S.) and worldwide. Public health guidance to stay at home and practice social distancing has had marked impacts on children's weight (1) and has likely influenced children's diet-related behaviors (2).

Although preparation of meals at home is typically associated with lower intakes of nutrients of concern including salt, saturated fat, and added sugar (3, 4), findings of studies examining impacts of COVID-19 related stay-at-home orders on dietary intake among adults are mixed (5), and evidence on pandemic-related dietary changes among children in the U.S. is lacking.

Recent survey data in the U.S. indicate that about half of U.S. adults reported consuming more "unhealthy snacks/desserts" and approximately one-third of U.S. adults reported drinking more SDs, during, compared to before, the pandemic (6). Given that excess added sugar intake is a well-established risk factor for obesity and cardiometabolic disease (7) and children's SD intake already exceeded recommendations prior to the pandemic (8), these trends are of particular public health concern. Recent studies have reported increases in SD intake during the pandemic among U.S. adults (6, 9), yet studies examining changes in children's SD intake during the pandemic, to our knowledge, have not been conducted.

Elucidating impacts of the COVID-19 pandemic on children's SD consumption is paramount because alterations in dietary behaviors during the pandemic may persist longer-term. Furthermore, time away from school and structured activities is known to exacerbate key risk factors for overweight and obesity among children (10, 11). For example, poorer dietary intake, including higher consumption of SDs and highly processed snack foods and desserts ("junk food"), is reported during the summer months, along with greater sedentary time and use of screens (e.g., television, video games, computers) (11). These patterns of obesity risk behaviors may be worsened in the context of COVID-19 related closures and stay-at-home orders, given limited access to fresh groceries, and cancellation of youth sports and other structured programming (2). In addition, the home environment (e.g., availability of SDs at home, parental modeling of SD consumption) is a well-established contributor to excess SD consumption among children (12–14), and may be especially problematic in light of increased time spent at home during the COVID-19 pandemic. Herein, we report findings of a qualitative study designed to examine effects of the COVID-19 pandemic on children's SD consumption and related dietary behaviors.

MATERIALS AND METHODS

In-depth qualitative interviews were conducted with 19 children and their parent/guardian (hereafter parent). The children who participated were enrolled in a larger, entirely virtual, intervention study ("Stop the Pop") designed to investigate children's physical and emotional feelings during three days of SD cessation, findings of which will be published separately. Children 8–14 years old and their parent were recruited from across the continental U.S. to participate in "Stop the Pop" using social media, community organization listservs, and parent-targeted study advertisements created by a professional recruitment agency. Interested parents completed a brief survey (administered via Qualtrics™) to determine study eligibility. Inclusion criteria were parent report that their child: (1) was between the ages of 8 and 14 years old, and (2) consumed ≥12 ounces of SDs (including regular soda, fruit drinks, fruit juice, sports drinks, and sweet tea) per day. Recruitment for "Stop the Pop" took place from November 2020 to June 2021, and the subset of 19 parent-child dyads who participated in the qualitative interviews was recruited between March 2021 and June 2021.

After providing informed consent (parent) and assent (child), and after completing the 3-day "Stop the Pop" protocol, children and their parent were invited to participate in an in-depth qualitative interview, conducted virtually via Zoom™. Interviews were conducted by a trained interviewer (ACS) using a semi-structured guide (**Supplementary Material**), which included questions about how the COVID-19 pandemic impacted the child's SD intake and eating behaviors, and if parental oversight of the child's SD intake had changed during the pandemic. Given that conceptualizing and articulating changes in dietary behavior during the pandemic may be cognitively challenging for children, the child and parent were interviewed together. Questions about changes in SD intake and overall diet during the pandemic were first directed to the child and then asked of the parent, whereas questions about changes in parental oversight of the child's SD intake were directed only toward parents. Data collection continued until saturation was reached, at which point, interviews had been conducted with 19 dyads. All interviews were recorded using Zoom™ and transcribed verbatim. Each dyad received a $25 Amazon gift card at the end of the interview as compensation for study participation.

Descriptive statistics were used to summarize the demographic characteristics of the child participants. Two coders (ACS and JHK) independently coded a subset ($n = 3$) of the transcripts using Microsoft Word and developed a shared codebook. Both coders then independently coded all transcripts in accordance with the shared codebook, using the NVivo Pro Software Package (version 12; QSR International Inc.; Burlington, MA, USA), and added new codes as they emerged. Once the codebook was finalized, transcripts were reviewed independently by both coders, and any discrepancies in coding were discussed. After completion of coding, the two coders independently identified key overarching themes and subthemes. Themes and subthemes were then collaboratively refined by the two coders, after which, representative quotations were selected.

RESULTS

Demographic characteristics of the 19 children who participated in qualitative interviews are shown in **Table 1**. Given that the study was designed to investigate changes in the children's SD intake and dietary behaviors during the pandemic, no demographic data were collected from parents. The sample of children was 57% female, and 63% of participants self-identified as non-Hispanic white. Forty-two percent of the participants indicated eligibility for free/reduced price lunch, and most of the children (79%) reported attending school virtually at the time of the interview.

TABLE 1 | Characteristics of child participants[a].

N	19
Age, years (mean ± SD)	11.5 ± 2.2
Female (*N*, %)	11 (57.9)
Race (*N*, %)	
White	12 (63.2)
Black	5 (26.3)
More than one race	2 (10.5)
Hispanic ethnicity (*N*, %)	2 (10.5)
Eligible for free or reduced-price lunch (*N*, %)	8 (42.1)
Attending school remotely (*N*, %)	15 (78.9)

[a]*No data on the demographic characteristics of the parents were collected.*

Two overarching themes emerged from the qualitative interviews. A key theme described by both children and parents was that changes in children's daily routines during the COVID-19 pandemic impacted their SD, snack, and meal intake (**Table 2**). The second overarching theme, as explained by parents, was that the pandemic altered parents' oversight of children's SD and snack consumption (**Table 3**). In addition, a minor theme identified was that changes in grocery shopping behaviors during the pandemic (e.g., stockpiling shelf stable foods due to grocery shortages, purchasing more SDs and snacks due to the whole family being at home) further promoted children's SD and snack intake.

Changes in Children's Daily Routines During the COVID-19 Pandemic Impacted Their SD, Snack, and Meal Intake

As shown in **Table 2**, five key themes related to how changes in children's daily routines during the pandemic impacted their SD and snack intake were identified. Most notably, increased time spent at home, rather than in school, promoted excess consumption of SDs and snacks among children, according to both children and their parents. Increased SD and snack intake at home was commonly attributed to having unrestricted access to SDs and snacks, the child experiencing boredom, and a lack of scheduled or structured eating times. Skipping breakfast when attending school virtually was also commonly reported by children and corroborated by parents. However, parents also explained that changes in the child's daily routine during the pandemic led to favorable dietary changes, including making healthier choices as a result of not being "on the go" and cooking more meals at home, as opposed to eating out. Some children and parents also described a shift in the types, rather than the volume, of SDs the child consumed as a result of the pandemic; for instance, consuming fewer juice boxes and sports drinks, due to not needing to bring a lunch to school and having fewer sports and extracurricular activities.

The COVID-19 Pandemic Altered Parents' Oversight and Views of Children's SD and Snack Consumption

As shown in **Table 3**, three key themes were identified pertaining to changes in parental oversight of the child's SD intake during the pandemic. Parents described removing prior restrictions on SDs, and in some cases, providing their children with SDs as a means of helping them cope with disturbances to daily life caused by the pandemic. For example, parents reported providing their child with SDs as a treat to make the child happy, and being more lenient about allowing their child to have SDs due to feeling bad for their child during the pandemic. Parents also described allowing their child more autonomy in making their own beverage choices during the pandemic. For instance, some parents explained that prior expectations that the child ask before helping themselves to SDs were no longer applicable. While these changes in parental oversight of their child's SD intake were commonly described as facilitators of increased SD consumption during the pandemic, some parents reported that being home together made them more aware of their children's SD consumption and/or made it easier for them to restrict their children's SD intake during the pandemic.

DISCUSSION

Our findings demonstrate that spending more time at home and out of school during the COVID-19 pandemic resulted in perceived increases in children's SD and snack intake. These findings are consistent with several recent studies reporting unfavorable effects of the COVID-19 pandemic on dietary intake among adults (6, 9), as well as recent reports of unhealthful dietary changes among children in other countries, including Italy (15) and China (16). Increases in SD intake and snacking during the pandemic are also supported by a large body of evidence demonstrating that unhealthy weight gain among children occurs disproportionately when out of school (i.e., during the summer months), compared with during the school year (17, 18).

Greater access to SDs and snacks while at home was described by both parents and children as the predominant contributor to reported increases in children's SD and snack consumption during the pandemic. This is not surprising, as the contribution of physical aspects (e.g., availability) and social aspects (e.g., parental modeling, family meal practices) of the home environment to children's dietary intake is well-established (12, 14). Availability of SDs in the home is positively associated with SD intake among youth (19, 20), and similar findings have been reported with regard to intake of energy-dense snacks (21). A recent cross-sectional study in the U.S. indicated that one-third of parents increased the amount of high-calorie snack foods, desserts, and sweets available in the home during the pandemic, while nearly half (47%) reported increases in the availability of non-perishable processed foods (22). These shifts in the home food environment during the COVID-19 pandemic may have further exacerbated increases in children's SD and snack intake behaviors. In addition, parent modeling of SD intake is another well-described contributor to children's SD intake (23). Given that SD intake also increased among adults during the COVID-19 pandemic (6), amplified parent modeling of SD consumption may have further contributed to the reported increases in children's SD intake.

TABLE 2 | Changes in children's daily routines during the pandemic impacted their sugary drink, snack, and meal intake.

Theme Subtheme	Selected relevant quotations[a]
Theme 1: Increases in SD consumption due to being at home	
Access to SDs	"Well, since I'm at home almost every day, I have more access to [sugary] drinks." (C) "I've just been drinking more stuff because it's more available to me." (C) "Because he's home everything is accessible, where he wouldn't have that at school - he wouldn't be able to just go in the fridge and get a soda." (P) "I think it's increased for the simple fact that they're home all day instead of at school. So, at school he's drinking water from the water fountain or his water jug that he takes to school, but since he's home he can just come down and get in the refrigerator and drink whatever." (P)
Drinking SDs due to boredom	"When there's nothing to do, I need my energy up so I don't die of boredom. So, I try to drink sugary drinks to get my energy up so I can actually look alive." (C) "On my breaks [from virtual school], I just get bored, so I eat or drink." (C) "I think because one, he's bored, and two, he's got nothing else to do. It's either drink or eat something." (P) "I think it's increased because he's at home all the time, so he's not occupied with going to class. And between classes, he doesn't have his friends here, nothing to occupy him beyond TikTok." (P)
Theme 2: Increases in snack intake due to being at home	
Access to snacks	"I've been eating a lot more, because there's a lot more food to eat…I'm around food more, instead of being somewhere else for 7 hours a day." (C) "We have a big pantry that's all stocked, and so she just has access to anything all the time." (P) "Because he's home everything is accessible, where he wouldn't have that at school. He wouldn't be able to just go in the fridge and get a soda or get snacks." (P) "What increases is the snacking in between because you have complete access to your kitchen all day whereas if you were at school you would not." (P)
Lack of scheduled eating times	"Because he's not at school, so he's here able to get a snack or come down and make something whenever he feels like it." (P) "I think our kids have all turned into grazers and eat whenever they feel hungry, which definitely was not the norm during regular school because they were only allowed at snack time and lunchtime. But at home they've been allowed a little bit more flexibility." (P) "The accessibility to snacks is different, because you taking your lunch box is one thing, and then, you know, given your time constraints at school, you can't just have a snack whenever you want it." (P) "After being in school all day, she will eat whatever's there because she's hungry because she doesn't really eat the school lunches; so, she's extremely hungry when she gets home…Now that she's home, the food is here, and she doesn't really want to eat, and she just wants to snack here and there." (P)
Snacking due to boredom	"Before, I always had something to do. But now I'm just like...nothing to do. You come from school and nothing else. That's it. End of the day. Snack, snack, snack." (C) "I think I eat a lot more often [during the pandemic] because I sat at home and did absolutely nothing, so I just ate." (C) "Just definitely more snacking because there is more just sitting around, playing games on the computer. It's just us around the house…everyone's just in shorts and t-shirt and just grabbing a package of goldfish or something, in the middle of class." (P) "Definitely a lot more snacking... not necessarily out of hunger, but boredom." (P)
Theme 3: Healthier choices due to being home	
Being "on the go" less frequently	"We have less convenience foods...before the pandemic, our kids were involved in scouts and 4H and we were running a lot more. So, we were grabbing, you know quickie stuff." (P) "I'm not buying them [snack foods] as often because I don't feel that we need the 'on the go' things so much, because we're home." (P) "I can cut up an apple, we're not in the car, or on the road, so we don't have to have the easy, open snacks anymore." (P)
Not going to school or activities	"On the way home [from school], I'd just go buy soda for myself. But, but when I was in quarantine like I didn't do any of that." (C) "When I was in middle school, I would eat out and I would go outside for lunch every single day and get a soda every single day." (C) "Even if the school is open, they have nothing going on there… no events, no parties, no celebrations, no birthdays [with SDs]; nothing is going on either in school or outside of school." (P)
Theme 4: Changes in daily routines impacted meal preparation and intake	
More child involvement in cooking	"She's also looking online for more stuff…mainly recipes, she started cooking on her own." (P) "We're actually cooking. We're cooking together every night now." (P) "Now that he's helping cook, he's actually putting onions in things and doesn't mind them." (P)
Cooking instead of eating out	"We didn't do takeout at all for like the first like 7-8 months, so like we were cooking at home a lot, everyone was eating like fresh, you know, like homemade meals." (P) "I cook more. So, we're eating more healthier meals, because I'm cooking every day, whereas before it was "go-go-go" and I wasn't always cooking. It was more, 'let's grab a bowl of cereal'– but at home, I'm cooking more." (P) "She's been here, so rather than just taking a sack lunch to school, it just allows more time to be able to come down and make different foods…So, she's been eating more variety, healthy foods. Yeah making good choices." (P)
Skipping breakfast	"I'll stay in bed and like, usually there's times where I'll just stay in bed and I won't eat until someone actually makes me eat." (C) "I used to eat breakfast before school, but now I don't really eat breakfast that much." (C) "I definitely noticed that she hasn't been eating breakfast. I work from home quite a bit lately as well and sometimes I don't even see her until lunch time." (P) "In school, there would be breakfast and lunch...at home, he won't eat breakfast." (P)
Theme 5: Changes in daily routines impacted the types of beverages consumed	
Consuming different types of beverages	"I usually have a juice box every day because I take it for lunch, but I didn't need to drink a juice box every day [during the pandemic], so I usually drink something else." (C) "When he had his sports and stuff, it was more the sport drinks, instead of everything else. So, I guess the volume would have been similar, but what it is he's drinking has changed." (P) "I think more or less, a better way to explain is not that her sugary consumption has increased, so much as what particular thing if that makes more sense." (P)

[a] *Child responses are indicated by (C) and parent responses by (P) following the quotation.*

TABLE 3 | The pandemic altered parents' oversight of children's SD consumption.

Theme Subtheme	Selected relevant quotations[a]
Theme 1: Less restrictions on children's SD consumption	
Provision of SDs as a coping mechanism	"As ridiculous and counterproductive as it sounds, I think that we were a lot more lenient. I've noticed I was buying a lot more treats and stuff…foods that the kids would be excited about which is usually sugary stuff. We went a little wild with the treats…just trying to compensate for them being stuck at home and bored." (P) "That was the only way I could get him to sit down for some of his classes…was to give him his fruit juice or whatever he wanted." (P) "I'm a little more lenient. You tend to, you know, feel bad for situations." (P)
Theme 2: More child autonomy in making beverage choices	
Less parental oversight	"Before COVID, my mom used to be strict-strict about drinks, I wouldn't necessarily be drinking things besides water, because, instead of now where you have to get at least one drink of water a day, before you could only have one juice a day." (C) "He doesn't ask anymore. When he goes to grab Capri Suns, he used to ask. Now he just grabs it, and doesn't say anything. I've caught him sitting playing video games, with the whole Capri Sun box next to him." (P) "Previous to the pandemic, I was a little more mindful of what he was drinking. But now we're 400 days in of being together all the time. And I guess we've gotten to a point where if you're thirsty, just get something to drink. Just grab a drink." (P)
Theme 3: More parental awareness of child's SD intake	
More parent awareness	"I think we actually see more of their consumption, because at school, we didn't see what she was drinking other than what we either included in cold lunch, or we knew she was getting milk at snack and lunch time." (P) "[Before the pandemic] I didn't know what he drinks because he gets money and never tells us what he's drinking, and now, it's more in control. So, we will see what he's drinking." (P) "It [the pandemic] made me realize how much sugary drinks we have in this house and how much is being consumed." (P)

[a] *Child responses are indicated by (C) and parent responses by (P) following the quotation.*

Children and parents in our study also commonly described the lack of scheduled meal and snack times, and cancellation of extracurricular activities, as reasons for reported increases in their children's SD and snack intake. This finding is consistent with the "structured days hypothesis (SDH)" (10), which has been proposed to explain accelerated weight gain among children during the summer months. The SDH posits that compared with the school year, during which children follow a consistent, structured, and regimented schedule with adult supervision, the summer months typically consist of less structure and more child autonomy (10). This lack of structure provides children with more opportunities to eat (as opposed to scheduled snack and mealtimes in school) and may increase the likelihood that children make poor dietary choices (10).

Parents also described loosening restrictions on their child's dietary intake during the pandemic, which has also been reported among parents of younger children (24), and providing SDs and treats to help their children cope with disruptions to daily life. These behaviors are concerning because indulgent parenting (25), where children have freedom to eat and drink whatever they wish, and emotional eating (26), where intake of foods high in sugar and/or fat to reduce the intensity of negative emotions, are both associated with excess weight gain among children (25, 26). Marked increases in depression and anxiety among children during the COVID-19 pandemic (27) may also have contributed to reported increases in SD and snack intake, given that psychological distress is associated with overeating among youth (28).

Despite the nearly unanimously reported increases in children's SD intake and snacking, parents reported some favorable impacts of the COVID-19 pandemic on children's diets, specifically with regard to cooking at home and eating healthier meals. Increases in cooking during the pandemic were reported in a recent scoping review (5), which also demonstrated that the pandemic had both favorable and unfavorable effects on dietary intake. Parents in our study explained that having more time and having fewer other commitments (i.e., not being on the go) were key reasons for cooking more frequently during the pandemic, consistent with prior work describing a perceived lack of time as a barrier to cooking healthy meals at home (29, 30). As has been reported in other recent publications (31, 32), parents also explained that their child was more involved in cooking meals during the pandemic. Given that cooking at home is associated with healthier dietary patterns (33), the shift toward more cooking during the pandemic may lay the groundwork for sustained improvements in meal healthfulness beyond the pandemic. Greater child involvement in cooking also holds promise, as learning cooking skills at an early age is positively associated with higher diet quality (34). However, it is unclear whether these benefits will persist, given that by mid-2021, national food sales outside the home began to exceed food at home for the first time since the pandemic began (35).

While our findings offer novel insights into impacts of the COVID-19 pandemic on children's SD, snack, and meal consumption, the study was subject to several limitations. First, the children's responses may have been influenced by interviewing the parent and child together, leading to possible contamination of the data collected. In addition, the small sample size precluded comparing differences in pandemic-related dietary changes based on participants' race, ethnicity, or household income. This is an important limitation because youth from low-income and/or minority backgrounds are most susceptible to weight gain when out of school (36); thus, increases in SD and snack intake reported during the pandemic may worsen already marked health disparities. Another limitation was the enrollment of children who reported habitual daily consumption of SDs (per inclusion criteria for "Stop the Pop"); therefore, the extent to which the pandemic may have impacted

SD intake among less frequent SD consumers could not be assessed. The parents' work environment (remote vs. in-person) also may have changed as a result of the pandemic and influenced children's SD intake and related dietary behaviors; however, data on the parent's work environment were not collected. It is also important to note that participants in the present qualitative study comprised a subset of individuals participating in a larger intervention study of short-term SD cessation. It is therefore possible that these individuals may have already had a high awareness or concern about SD intake, and thus, their description of changes in SD intake behaviors during the pandemic may not reflect those of the general population.

Taken together, our findings call attention to concerning increases in SD and snack intake among children during the COVID-19 pandemic, the effects of which may be partially offset by increases in cooking and consumption of healthier meals. Surveillance of children's diets throughout and following the pandemic is needed, as the extent to which the perceived increases in SD and snack consumption will persist longer-term is presently unclear. While these dietary changes were reported in the unique context of the COVID-19 pandemic, our findings may apply more broadly to other prolonged periods of unstructured, out-of-school time (i.e., the summer recess). Intervention strategies to improve the home food environment, such as reducing the availability of SDs and energy-dense snacks are needed, along with efforts to educate parents about optimal food parenting practices and equip children with more adaptive, non-food related coping skills.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Institutional Review Board at the George Washington University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

AS, JK, AV, and JS designed the research. AS and JK performed the analyses. AS wrote the first draft of the manuscript. All authors were involved in editing the manuscript and approved the final version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fnut.2022.860259/full#supplementary-material

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Purchases of Fruit and Vegetables for at Home Consumption During COVID-19 in the UK: Trends and Determinants

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This paper addresses the issue of fruit and vegetable purchases in the UK during the COVID-19 pandemic. The study is motivated by the importance of fruit and vegetables for human nutrition, health and reduction of population obesity, especially in the UK where per capita consumption is still below recommended levels. A rich panel dataset was used reporting actual shopping places and quarterly expenditure for at-home consumption of fruit and vegetable purchases of 12,492 households in years 2019 and 2020. The unique dataset allowed us to compare expenditure for fruit and vegetables before and after the COVID-19 outbreak and to identify the main drivers of changes in purchases. Regression analysis found that expenditure increased ∼3% less than what expected given the overall increase in the numbers of at-home meals during lockdown. Also, Online shopping was found to be an alternative source for fruit and vegetables purchase during the pandemic. However, the expenditure for processed products grew more than the one for fresh products, resulting in a reduction of the relative share of the latter and possible deterioration of the diet quality.

Keywords: UK fruit and vegetable consumption, COVID-19, online shopping, panel data analysis, impact response framework

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INTRODUCTION

Fruit and vegetable consumption are an important part of human nutrition and a key component of the UK strategy to reduce obesity. Despite this, the UK per capita consumption of fruit and vegetables is below the recommended levels (1). The lockdown that followed the COVID-19 epidemic in March 2020 brought a number of constraints to households such as restrictions regarding access to shopping locations and allocation of time for shopping and cooking. These constraints as well as other factors coming from the market environment may have changed households' demand for fruit and vegetables.

In the described context, the purpose of this paper is to investigate how COVID-19 affected the purchases of fruit and vegetables in the UK. The analysis addresses not only the overall purchases but also a possible substitution between fresh and processed or preserved products during the pandemic. The objective of the research is not only to measure any change in diet, but also to identify the social and economic drivers of the change. The analysis of the causes is important to assess how much of the diet change was due to the pandemic *per se* and how much was due to the containment measures that were adopted by the government and ultimately to stipulate on future trends.

An Impact-Response Conceptual Framework

The effect of COVID-19 on fruit and vegetable purchases can be represented by an Impact-Response (IR) framework (2). In this model, changes in the variable of interest (purchases of fruit and vegetables) are determined by the response of a social group (UK consumers) to the impact (the social and economic consequences) of an exogenous event (the pandemic outbreak). The framework has been used in several COVID-19 related work [e.g., (3–8)]. The IR framework helps to understand interaction among variables and the outcome of the interaction. In this case, how the purchases of fruit and vegetables, UK consumers, and the consequences of the COVID-19 outbreak interact resulting in possible changes in fruit and vegetables purchases can be better explained. In particular, IR framework contributes to the understanding of the effects of COVID-19 on nutrition because it allows researchers to investigate the causes of a possible change in diet during the pandemic. To this end, this paper not only assess the difference in fruit and vegetables purchases during the period of interest, but it identifies the main factors driving the change.

Figure 1 summarizes the application of the IR framework. Based on a review of the literature we identified three main areas of impact of COVID-19: Psychological pressure, Financial distress and Containment measures. Consumers responded to these impacts in several ways: changing their mood, lifestyle and shopping habits and ultimately changing the purchases of fruit and vegetables.

Impact Areas of COVID-19

Psychological pressure is defined as the effect of the COVID-19 outbreak on the psychological wellbeing of UK populace [e.g., (9)]. In general, the pandemic emergency was associated with psychological issues such as stress, fear, anxiety, depression and frustration [e.g., (10, 11)]. An extensive literature suggested that COVID-19 Psychological pressure may influence food-purchasing behavior [e.g., (12)].

Financial distress is the second area of impact. COVID-19 affected the UK economy in multiple ways, including increasing business uncertainty (13), disruption of supply chains (14, 15) and ultimately higher unemployment rate (16). Despite large public subsidies, the economic consequences of the pandemic have been dire for many UK households (17). The resulting financial distress is expected to affect the purchases of fruit and vegetables depending on income elasticity of demand.

Finally, the spreading of the disease required adopting drastic containment measures, including lockdown, mobility limitations, school and non-essential business closure, and voluntary social distancing. This area of impact was particularly severe during the 1st months of the emergency, when government restrictions were in place and became less compelling at later stages of the pandemic (18).

Expected Responses of UK Consumers

The three areas of impact elicited responses from UK consumers. Based on our review of the literature, three main types were identified: Changes in mood and attitude, At-home lifestyle, and Pandemic shopping (**Table 1**).

Changes in Mood and Attitude

Response to Psychological pressure triggered changes in consumer mood and attitude, resulting in new purchasing behavior. In the early stages of the pandemic, even before

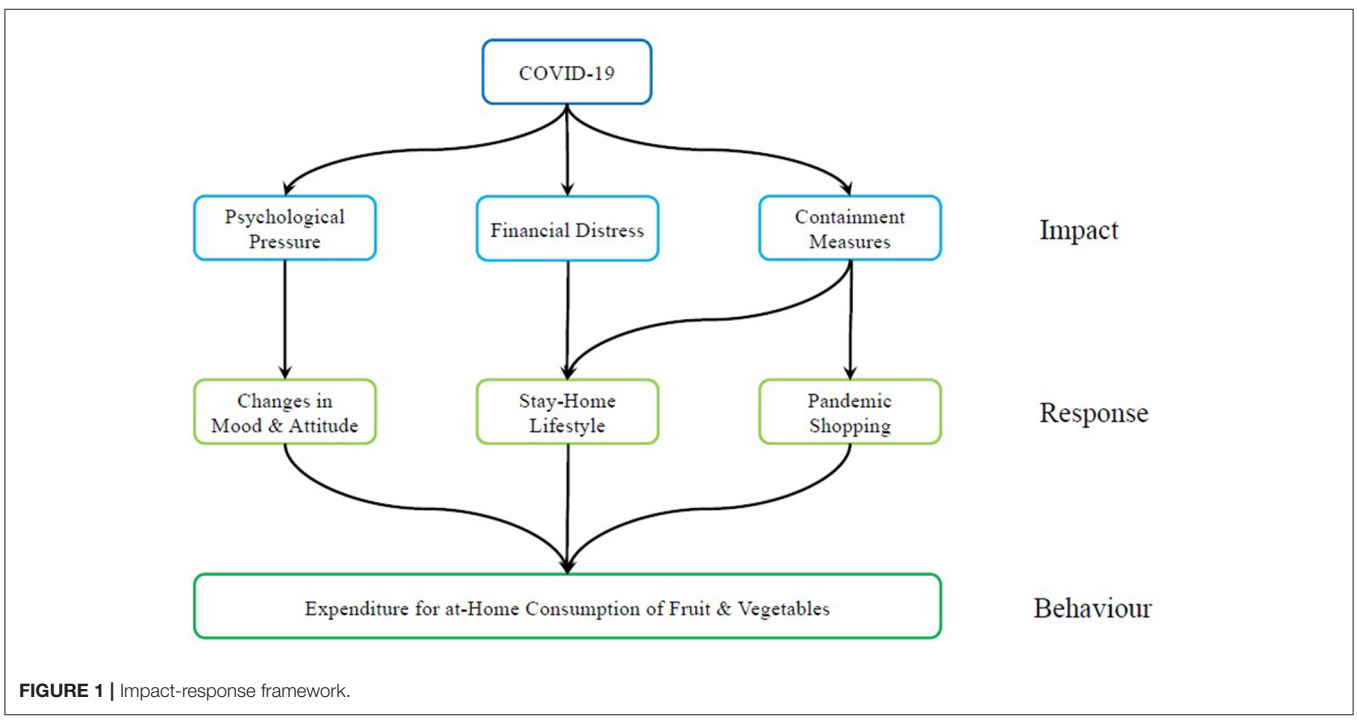

FIGURE 1 | Impact-response framework.

TABLE 1 | Consumer response to COVID-19, their expected effects on expenditure for fruit and vegetables and on the relative preference for fresh products over preserved/processed ones.

Consumer responses		Expected effects	
		On expenditure for fruit and vegetables	On preference for fresh over preserved fruit and vegetables
Changes in mood and attitude	Panic & hoarding	Increase	Decrease of fresh
	Health focus	Increase	Increase of fresh
	Comfort-seeking	Decrease	-
At-home lifestyle	Eating at home	Increase	-
	Adjusting budget	Decrease	Decrease of fresh
Pandemic shopping	Online shopping	-	-
	Fewer trips to store	-	Decrease of fresh
	Store choice	-	-

Source: Own elaboration based on the literature review.

the national emergency was declared, UK consumers displayed panic buying, and stockpiling behavior [e.g., (19, 20), which may be interpreted as a precautionary response to the fear of future scarcity and restrictive measures on mobility. Other studies showed that COVID-19 induced emotional status such as anxiety, depression or stress were associated with changes in eating habits such as emotional eating or binging (21, 22).

Concerns about future food availability, leading to hoarding and stockpiling behavior (19, 23), may result in a relative preference toward non-perishables processed fruit and vegetables over fresh ones. O'Connell et al. (24) analyzed a balanced panel data of 17,093 UK households from January 1, 2019, to August 9, 2020, and found that, there was a spike in household purchases prior to the first nationwide lockdown in March 23, 2020. The authors observed sharp increase in staples (including canned products) purchases relative to perishable products (including fresh fruit and vegetables) which showed a moderate increase only. Richards and Rickard (25) analyzed the Canadian fruit and vegetable market and indicated that consumers stockpiled frozen fruit and vegetables. The authors also predicted a switch toward online shopping after observing closure of food services. In the United States, Litton and Beavers (26) analyzed a recall dataset of Michigan State residents (survey was conducted from June 17 to June 29) and found that food-insecure residents were more likely to consume less fruits and vegetables (being it fresh, frozen, or canned) during the COVID-19 pandemic.

Psychological pressure can affect dietary choices in other ways as well. On the one hand, health concerns may result in a relative preference toward fresh fruit and vegetables due to a focus on healthy nutritional balance, hoping to boost human immune system and possibly the resistance to contagion (27–29). On the other hand, anxiety and fear may lead to an increase in purchases of comfort food such as snacks, confectionery, sweets, alcohol (30) to the possible detriment of fruit and vegetables.

Based on the literature, it is possible to conclude that changes in consumer mood and attitude due to psychological pressure may drive purchases of fruit and vegetables into different directions and the net effect on purchases depends on which component prevails.

Stay-Home Lifestyle

Response to the COVID-19 impact include adopting a stay-home lifestyle. Due to fear of contagion, restrictive measures, at-home working or involuntary unemployment, UK consumers spent more time at home than they did before the pandemic. The obvious consequence was a sharp decrease in the number of times they ate out and an increase in the budget expenditure for grocery product (including fruit and vegetables). Studies about the effect of stay-home lifestyle on dietary habits found conflicting results (31). On the one hand, it was associated with healthy eating due to home cooking [e.g., (32)]. On the other hand, confinement was found to lead to increase in consumption of comfort food, less exercise and more time spent on watching TV (33). The net effect of the two trends is an empirical question. Furthermore, it must be noted that changes in employment status may affect consumer response deeply.

Pandemic Shopping

Finally, UK consumers responded to the impact of COVID-19 by adjusting their shopping behavior, that is, the way they purchased food. Online purchases increased during the pandemic both from de-specialized retailers (such as Amazon) and specialized food retailers developing online services along their traditional "brick and mortar" stores (such as Tesco online) [e.g., (34, 35)]. Consumers optimized shopping frequency and store choice given the new sets of constraints to mobility and accounting for the possibility of contagion [e.g., (36)]. The emerging shopping behavior is expected to affect purchases of fruit and vegetables in two main ways. Firstly, changing food source (for examples, from far, large supermarket to local stores or to online); consumers are exposed to different assortments, and this may result in an adjustment in purchases. Secondly, the objective of reducing shopping frequency may lead to a preference for non-perishable goods in order to avoid waste and extend the time before a new trip to the store is needed.

Change in Fruit and Vegetables Purchases

The final objective of the study is to break down the overall change in fruit and vegetables purchases, measuring the effects

of each response. The final outcome is a quantitative evaluation comparing the relative magnitude of each factor.

MATERIALS AND METHODS

In order to achieve these objectives, a two-step statistical approach was developed. First, the variables describing changes in expenditure for at home consumption of fruit and vegetables and the three consumer responses to COVID-19 impacts were identified and measured. Second, an econometric model was used to estimate the contribution (relative effect) of each response to the change in diet.

The econometric model was necessary to investigate the causal relationship that is embedded in the IR framework. According to econometric theory, the regression coefficients measure the expected change in the expenditure for at-home consumption of fruit and vegetables due to a change in a response variable, keeping all other explanatory variables constant [e.g., (37)]. In this way, it is possible to single out and compare the contribution of each response.

Identification and Measurement of Variables

The Dataset

In order to explain the changes in expenditure, a subset of Kantar Worldpanel Homescan panel dataset was used. This recurring survey collects data about grocery purchases of a representative sample of UK households. Data are collected and certified by Kantar.

The use of this extensive survey allows us to provide a general estimate of the UK trends. However, because this is a multipurpose survey with predetermined questionnaire, it was impossible to collect *ad-hoc* information. Instead, it was necessary to use existing variables to measure the phenomena of interest. Therefore, the generality of the large sample was achieved at the cost of approximation of measurement.

The available dataset reported information about 12,492 UK households. For each individual household, data were reported about expenditure for fruit and vegetables and shopping places starting from January 1st, 2019 to December 31st, 2020. The information was aggregated by quarters of 13 weeks, which means that every household was observed 8 quarters in the dataset. In total, the dataset was composed of 99,936 observations (12,492 households in 8 quarters).

The use of quarterly data raises the issue of a proper identification and development of the pandemic period. In fact, the statistical analysis is based on the comparison of expenditure for at home consumption for fruit and vegetables before and after the COVID-19 outbreak. In the UK, the early cases were reported during February 2020, and the containment measure were adopted in March. Therefore, data of the first quarter 2020 report purchases before and after the disease outbreak. Because a precise measurement was not possible with the available data, it was assumed that the first quarter 2020 is part of the "before COVID-19" period. This choice was made because the disease became epidemic in the UK at the end of the quarter, and the majority of purchases in that period happened before the outbreak. Thus, the dataset is conventionally broken into two periods: from January 1st 2019 to March 31st 2020 is the "before COVID-19" period and from April 1st to December 31st 2020 is the "after COVID-19" period.

The panel was geographically balanced, and it covered seven regions: East with 1,349 households (10,792 observations), London with 913 households (7,304 observations), Midlands with 2,119 households (16,952 observations), North with 3,405 households (27,240 observations), South with 2,970 households (23,760 observations), Scotland with 1,104 households (8,832 observations) and Wales with 632 households (5,056 observations).

It was possible to use only a limited subset of the variables in the Kantar Worldpanel for this research. Available variables are described in **Table 2**. They included information regarding the purchases of fruit and vegetables, total grocery purchases, shopping places and individual household characteristics, such as age, sex and number of adults and children.

The dataset reported the per capita expenditure for fruit and vegetables as well. In the original dataset, fruit and vegetables were classified in the following 8 categories: fresh and processed potatoes (e.g., fresh new potatoes and mashed potatoes); fresh green vegetables (e.g., lettuce), other fresh vegetables (e.g., carrots) and processed vegetables (e.g., sweet pickles) and fresh fruits (e.g., apples), processed fruits (e.g., fruit salad) and fruit juices (e.g., apple juice). In order to focus on the substitution between fresh and non-fresh fruit and vegetable products, the 8 categories have been summarized into two groups: Fresh Fruit and Vegetables (including fresh potatoes, fresh green vegetables, other fresh vegetables and fresh fruit) and Processed Fruit and Vegetables (all other categories).

The information regarding shopping places included the expenditure for grocery products at different outlets. The shops were classified in 6 groups namely: club and bargain store (e.g., Costco), convenience (e.g., Holland and Barrett), discounter (e.g., Lidl), large store (e.g., Tesco), online (i.e., any purchase done via the internet such as Tesco online) and other retailers (e.g., farmshop/stall). The dataset reported the per capita expenditure for grocery by store type for each household in each quarter.

Using Dataset Variables to Measure Consumer Responses

The Stay-Home Lifestyle response was measured by per capita expenditure for all grocery products. The variable can summarize the two main drivers of the response: on the one hand, the increase in the number of meals that are consumed at home (leading to an increase in expenditure), and on the other hand, the possible income loss due to impact of the pandemic on the economy (resulting in a decrease in expenditure depending on income elasticity).

The Pandemic Shopping response was measured through the shares of total grocery expenditure of each store type, including online. In this way the model can account for changes in the choice of shopping places due to restrictions to consumer mobility.

Finally, the Mood response was elusive to capture with the available data and it was measured as a residual effect. By assumption, any systematic change in expenditure for fruit and vegetables after the pandemic outbreak that could not be explained by Stay-Home Lifestyle or Pandemic Shopping is attributed to this response. In order to purge the estimation from other factors as much as possible, individual characteristics of the households have been considered in the regression model. In this way, the estimation of the Mood and Attitude response is not affected by changes in fruit and vegetables purchases due to the individual factors. In the econometric model, the residual effect is computed using three binary variables identifying the second, third and fourth quarters of 2020 (**Table 2**).

Econometric Model

In order to estimate effects of the three types or response on fruit and vegetable expenditure, a random effect regression model was used. Appropriate statistical tests on the regression coefficients can be used to prove the existence and measure the magnitude of each response separately.

Equation (1) describes the functional form of the model:

$$y_{i,t} = \beta_0 + \sum_{k=1}^{K} (\beta_k + \gamma_k a_t) X_{i,t}^k + \sum_{j=1}^{J} \beta_j Z_{i,t}^j + u_i + e_{i,t} \quad (1)$$

where subscripts i and t refer to the i^{th} household in quarter t (when possible, the subscripts will be dropped for the sake of simple notation), and

- $y_{i,t}$ is the dependent variable.
- a_t is a binary variable that is equal to 1 if the observation refers to the "after COVID-19" period (the second, third or fourth quarter 2020) and zero otherwise.
- $X_{i,t}^k$ are the set of variables that are used to measure the Mood and Attitude, Stay-Home Lifestyle and Pandemic Shopping responses as listed in **Table 2**. Their effect on $y_{i,t}$ is expected to change after the COVID-19 outbreak, because of impact of the three effects on consumer behavior.
- $Z_{i,t}^j$ are the set of *auxiliary household information* which effect on $y_{i,t}$ is expected to be unchanged after the COVID-19 outbreak.
- β's and γ's are regression parameters.
- u_i and $e_{i,t}$ are error terms.

According to the textbook dummy variable regression technique, an estimate of a γ_k parameter that is statistically different from zero allow us to reject the null hypothesis that the effect of X^k on y did not change after the COVID-19 outbreak. This property was used to test for the three effects. A change in the regression parameters of interest change after the COVID-19 outbreak can be considered as statistical evidence of the effect of the response to COVID-19 on expenditure for at home consumption of fruit and vegetables. The statistical tests are structured as follows:

A. The test for the effect of Lifestyle response on the dependent variable is based on the following hypotheses:

H_0: $\gamma_{\text{PCEX\_TOT}} = 0$ (no effect)

H_1: $\gamma_{\text{PCEX\_TOT}} \neq 0$ (Lifestyle response affected expenditure)

where $\gamma_{\text{PCEX\_TOT}}$ is the γ coefficient of the variable PCEX_TOT. If the null hypothesis is rejected, it is concluded that Lifestyle

TABLE 2 | Dataset description and measurement of consumer responses to COVID-19.

Description	Variables	
Per capita expenditure for fresh fruit &vegetables	PCEX_FFV	Dependent variables of the regression models
Per capita expenditure for processed fruit &veg.	PCEX_PFV	
Expenditure for Fresh Fr. &Veg/Total Fr. &Veg. Exp.	SHARE_F	
Per capita expenditure for all grocery products	PCEX_TOT	Meas. Lifestyle R.
Convenience store share of total exp. for all grocery	CONV	Measures of the pandemic shopping response
Discount store share of total exp. for all grocery	DISC	
Large store share of total exp. for all grocery	LARGE	
Club, Barg. & Other Store Share of To. Exp. for All Gr.	OTHER	
Online Share of Total Exp. for All Grocery.	ONLINE	
Seasonal binary variable (1 if 2nd quarter '19, 0 otherw.)	$Q2_{19}$	Measures of mood and attitude response
Seasonal binary variable (1 if 3nd quarter '19, 0 otherw.)	$Q3_{19}$	
Seasonal binary variable (1 if 4nd quarter '19, 0 otherw.)	$Q4_{19}$	
Seasonal binary variable (1 if 2nd quarter '20, 0 otherw.)	$Q2_{20}$	
Seasonal binary variable (1 if 3nd quarter '20, 0 otherw.)	$Q3_{20}$	
Seasonal binary variable (1 if 4nd quarter '20, 0 otherw.)	$Q4_{20}$	
Age of primary shopper	AGE	Auxiliary household information
Sex of primary shopper (1 if male, 0 otherw.)	SEX	
Number of children in the household	NCH	
Number of adults in the household	NAD	

response affect the expenditure for fruit and vegetables. A positive (negative) γ_{PCEX_TOT} implies that the dependent variable increased more (less) than expected given the increase in the total expenditure for grocery. This means that after COVID-19, having more meal at home does not result in an increase in expenditure for fruit and vegetables in the same proportion as before COVID-19.

B. The test for the effects of Pandemic Shopping response are:

H_0: $\beta_{STR}+\gamma_{STR} = 0 \; \forall$ STR = {CONV, DISC, LARGE, OTHER, ONLINE}

H_1: at least one $\beta_{STR} + \gamma_{STR} \neq 0$

where γ_{STR} and β_{STR} are the regression coefficients of the expenditure share of the corresponding store type. If the null hypothesis is rejected, a change in the shopping place affected the dependent variable in the after COVID-19 period. In this case, it is possible to conclude that mobility restrictions affected not only the type of stores but also the way consumer shopped during the pandemic and ultimately their expenditure for fruit and vegetables.

C. The test for the effect of Mood and Attitude response is:

H_0: $\gamma_{Qi} = 0 \; \forall \; Q_i$ = {2020 quarter 2, 2020 quarter 3, 2020 quarter 4}

H_1: at least one $\gamma_{Qi} \neq 0$

If the null hypothesis is rejected, the regression intercepts after the COVID-19 differ from those before. This means that there is a systematic component that is not captured by the other variables, that can be attributed to this response.

In the next section, descriptive statistics and the results of the regression estimates are presented and discussed.

RESULTS

Descriptive Statistics

In this section the data are described, with a focus on the measures of Lifestyle and Pandemic Shopping responses that have been introduced in the previous section. A descriptive analysis of the trends in expenditure for Fresh and Processed Fruit and Vegetables is presented as well.

Measuring Stay-Home Lifestyle Response

Total expenditure for grocery was used as concise measure of changes in lifestyle. **Figure 2** reports the distribution of the per cent change in the UK per capita expenditure for all grocery goods before and after the COVID-19 outbreak. The mean value of the distribution is 17.2% and the standard deviation is 26.6. The 95% confidence interval for mean is between [16.7, 17.6]. The median of the distribution is 14% and the first and the third quartile are 0.9 and 29.5%, respectively. The share of UK households experiencing a reduction in per capita grocery expenditure is 16.2%. Summarizing, majority of UK households increased their grocery expenditure between 10 and 30% after COVID-19 outbreak and approximately one household out of six reduced the expenditure.

The data confirm the expected increase in per capita grocery expenditure due to the stay-home lifestyle. However, the analysis of the distribution shows that a non-negligible number of households experienced a reduction in the budget for grocery, possibly because of the financial distress impact of COVID-19.

Measuring Pandemic Shopping Response

After the COVID-19 outbreak, consumer mobility was constrained by government measures and fear of contagion. Changes in shopping behavior are used to measure such effect.

Figure 3 reports the per cent shares of expenditure for all grocery product by type of store. The per cent share of online purchases increased from an average of 9.8% before COVID-19 outbreak to an average of 15.6% after the outbreak. In the same period, the share of large stores decreased from 59.1% to 54.3%. The remaining store types exhibited minor changes in share.

Although the aggregate data suggest an overall shift of consumer expenditure from large stores to online, individual behaviors exhibit heterogeneous patterns. **Figure 4** reports a by-plot comparing the per cent change in the expenditure for all grocery goods at large stores and the one from online purchases. The majority of observations lie in the second cartesian quadrant of the plot, confirming the strong substitution effect between the two outlets. On the diagonal of the second quadrant, a reduction in the share of expenditure at large stores is matched by an increase of the share of online purchases exactly. However, the substitution is not perfect, because a remarkable number of observations is far from the perfect negative correlation line (the red line in the figure), suggesting that online shopping acted as substitute for other outlets as well.

Trends in Expenditure for Fruit and Vegetables

Using the dataset, the average per-capita expenditure for at-home consumption of fresh fruit and vegetables and processed fruit and vegetables was computed in each quarter of 2019 and 2020. The results were compared with the average per-capita expenditure for grocery goods in the same period, in order to account for seasonality in fruit and vegetables consumption. **Table 3** reports the results.

The data in **Table 3** show a statistically significant increase in the expenditure for at home consumption of both categories of fruit and vegetables during the COVID-19 period. However, the per-capita expenditure for fresh fruit and vegetables in the fourth quarter of 2020 grew less than the per-capita expenditure for all grocery goods, suggesting a change in the composition of the consumption basket.

Figure 5 compares the percentage share of fresh fruit and vegetables and processed fruit and vegetables per-capita expenditure on the per-capita expenditure for all grocery goods. The graph shows minor differences between shares in 2019 and 2020 once seasonality has been accounted for. Only in the first and third quarter of 2020, the expenditure for fruit and vegetables was a lower share of grocery expenditure than in 2019, but even in those quarters, the difference was limited (about 0.5% points). The data suggests that COVID-19 had a limited effect on consumers' decisions on the allocation of the overall budget for grocery to fruit and vegetables purchases.

Similarly, the expenditure shift from fresh to processed fruit and vegetables was limited. **Figure 6** reports the per-cent shares

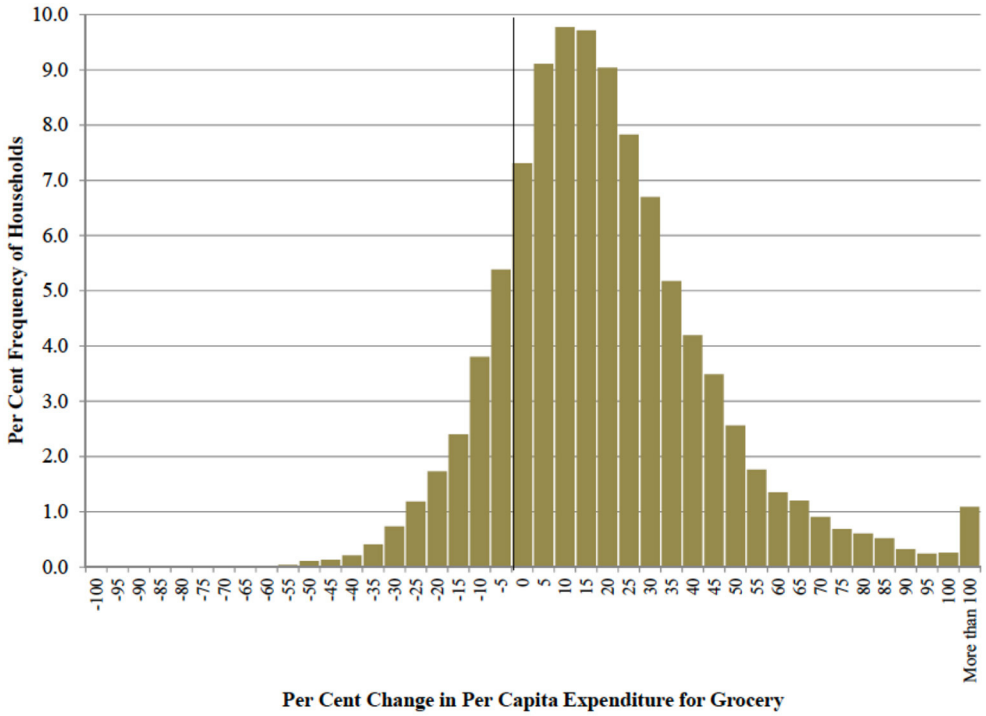

FIGURE 2 | Distribution of UK households by class of per-cent change in per capita expenditure for grocery goods before and after COVID-19 lockdown (per cent frequencies).

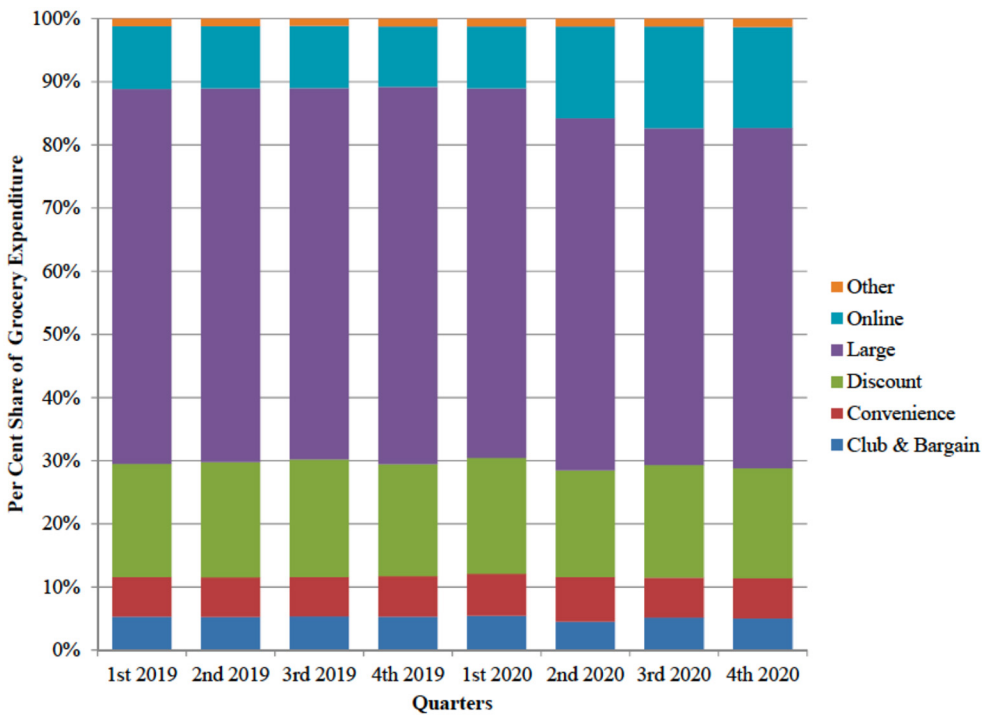

FIGURE 3 | Expenditure for all grocery goods by types of store (UK, per cent share).

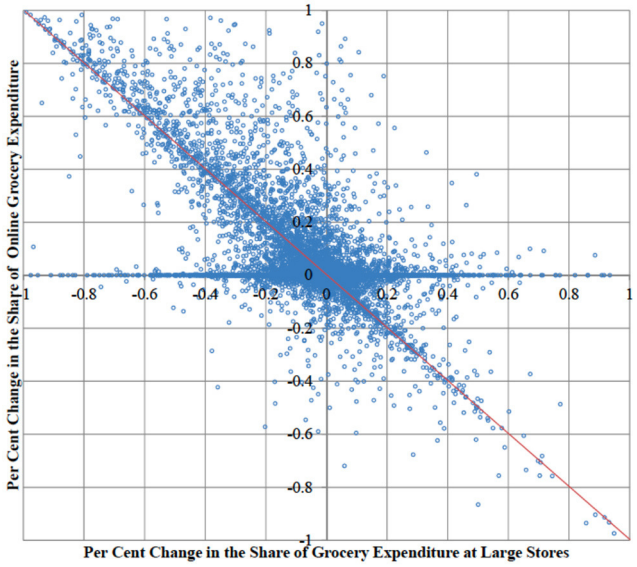

FIGURE 4 | Plot of per cent changes in household grocery expenditure at large stores and online before and after Covid-19 outbreak (UK, data are individual households).

of the two categories on total fruit and vegetable expenditure. Again, after accounting for seasonality, only minor differences are observed.

In order to account for the heterogeneity in consumer responses to COVID-19 further, the household distribution of the expenditure for fruit and vegetables was investigated. **Figure 7** shows that on average 36.6% of consumers experienced a decrease in expenditure for fruit and vegetables after COVID-19, compared to the same quarter in the previous year. The figure was 46.6% in the before COVID-19 winter quarter. At the same time, 39.6% of the consumers in the sample increased their expenditure by more than 10% with respect to the same quarter in 2019. In the period before COVID-19 winter quarter they were 27.2%.

The analysis of quarterly data (**Table 3**) showed a spike in expenditure for at home consumption of fruit and vegetables during the second quarter 2020, that is right after the COVID-19 outbreak. Similarly, the unchanging mean in expenditure share for fresh fruit and vegetables is the result of a symmetric distribution where roughly half of the consumers increased the relative expenditure for fresh produce and the other half reduced it (**Figure 8**). To account for data heterogeneity, a regression model on individual household data was run.

Regression Results

Table 4 reports the description and summary statistics of the variables used in the regression model. Data report an increase in the expenditure for both Fresh and Processed Fruit and Vegetables in the after COVID-19 period. The share of Fresh Fruit and Vegetables expenditure did not change after the pandemic outbreak.

To identify the factors affecting the change in expenditure, a set of three regressions were run, with dependent variables being per capita expenditure for Fresh Fruit and Vegetables (PCEX_F), per capita expenditure for Processed Fruit (PCEX_P) and Vegetables and expenditure share of Fresh Fruit and Vegetables on total expenditure for fruit and vegetables (SHARE_F). **Table 5** reports the results. It must be noted that the regression of the fresh fruit and vegetable share (Equation 3) reports a very low value of R^2 suggesting caution in the interpretation of the results from this estimation. The fitting of the other two regression is satisfactory, the R^2 being equal to 0.36 in the case of expenditure for Fresh Fruit and Vegetables and 0.41 for Processed Fruit and Vegetables.

The products of the indicator variable *a* (identifying quarters in the post-COVID-19 period) with the variables related to per

TABLE 3 | Average per-capita expenditure for at-home consumption of fresh fruit and vegetables, processed fruit and vegetables and grocery goods (UK 2019–20, pounds).

		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Fresh fruit & vegetables	2019	38.0	39.8	38.2	33.4
	2020	38.0	46.7	41.3	36.5
	Diff.	0.0	6.8(*)	3.0(*)	3.1(*)
	% Diff.	0.0	17.1	7.9	9.2
Processed fruit & vegetables	2019	26.1	26.0	25.1	26.8
	2020	27.6	30.9	28.4	30.0
	Diff.	1.5(*)	4.8(*)	3.3(*)	3.1(*)
	% Diff.	5.8	18.5	13.3	11.6
All grocery goods	2019	356.3	361.5	351.3	387.8
	2020	375.0	427.0	400.3	429.3
	Diff.	18.6(*)	65.5(*)	49.0(*)	41.5(*)
	% Diff.	5.2	18.1	14.0	10.7

(*)Difference in the average expenditure between 2019 and 2020 is statistically significant at 95% confidence level.
The statistical test used is the t-test of equality of sample means.

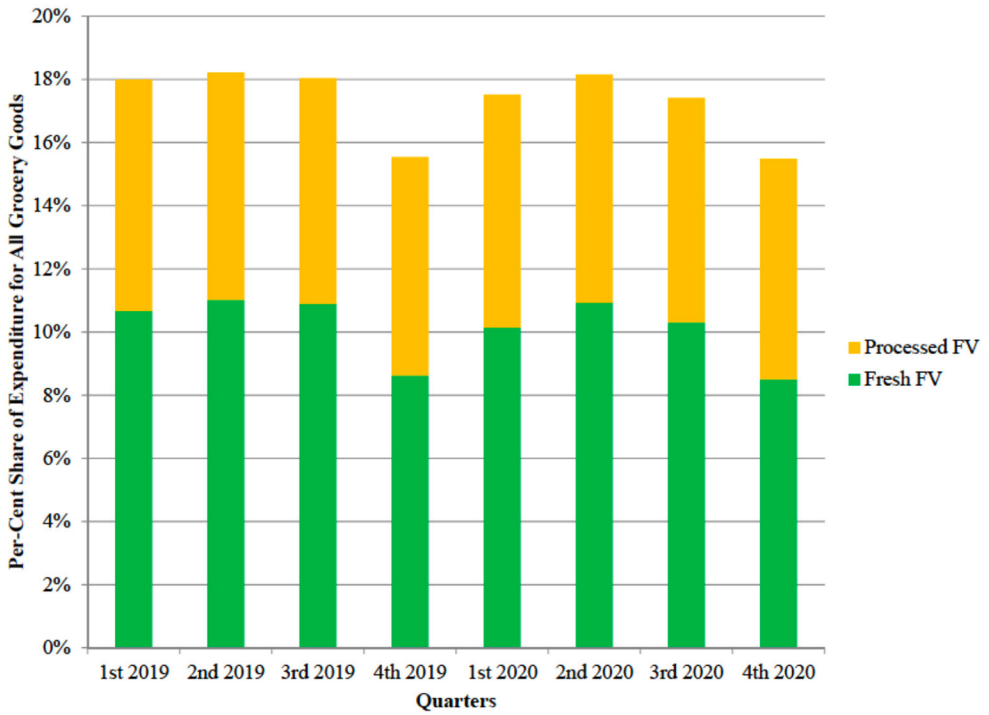

FIGURE 5 | Per-cent share of per-capita expenditure for all grocery goods of fresh fruit and vegetables and processed fruit and vegetables (UK, years 2019–2020).

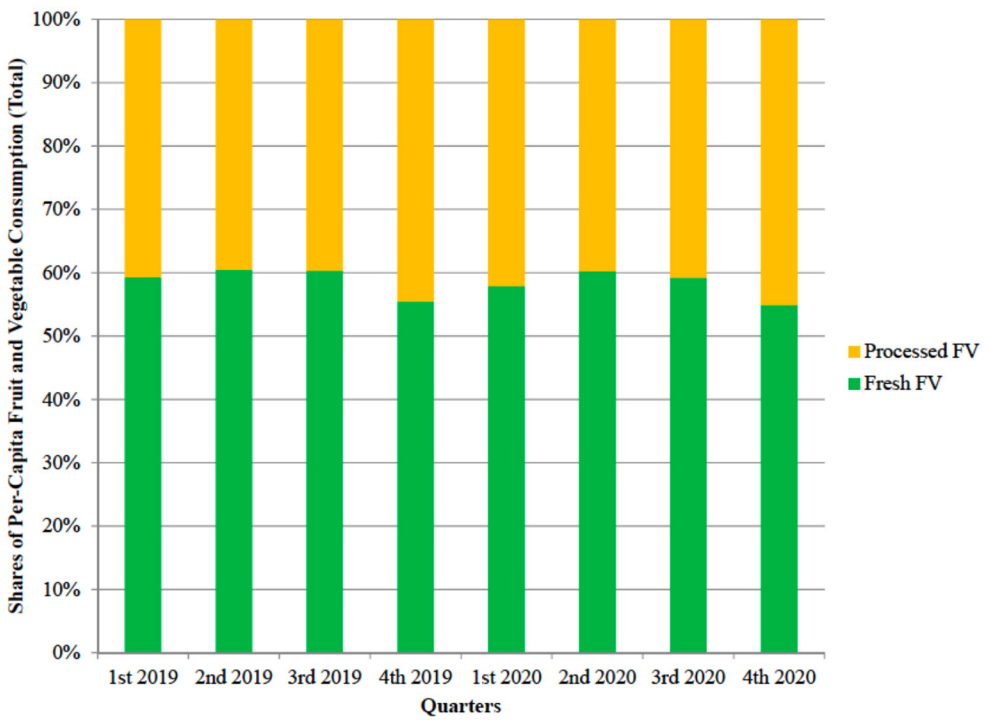

FIGURE 6 | Break down of per-capita expenditure for fruit and vegetables (total) into expenditure shares for fresh fruit and vegetables and processed fruit and vegetables (per-cent shares, UK, years 2019–2020).

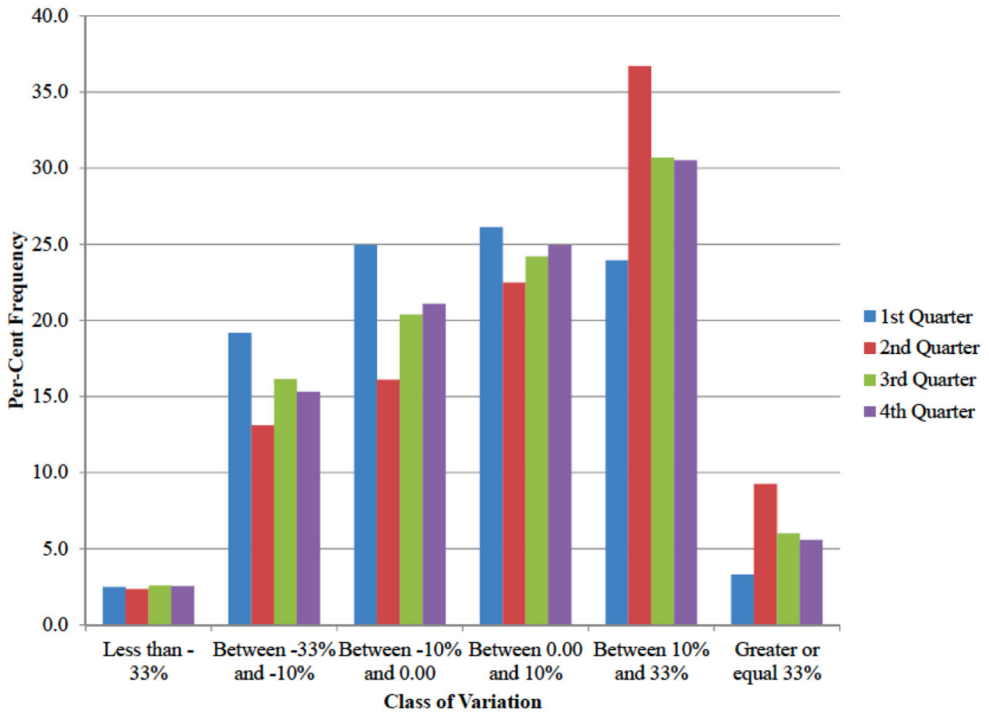

FIGURE 7 | Distribution of households by class of per-cent change in household expenditure for fruit and vegetables (per-cent frequencies, quarters 2020 compared to same quarter in 2019).

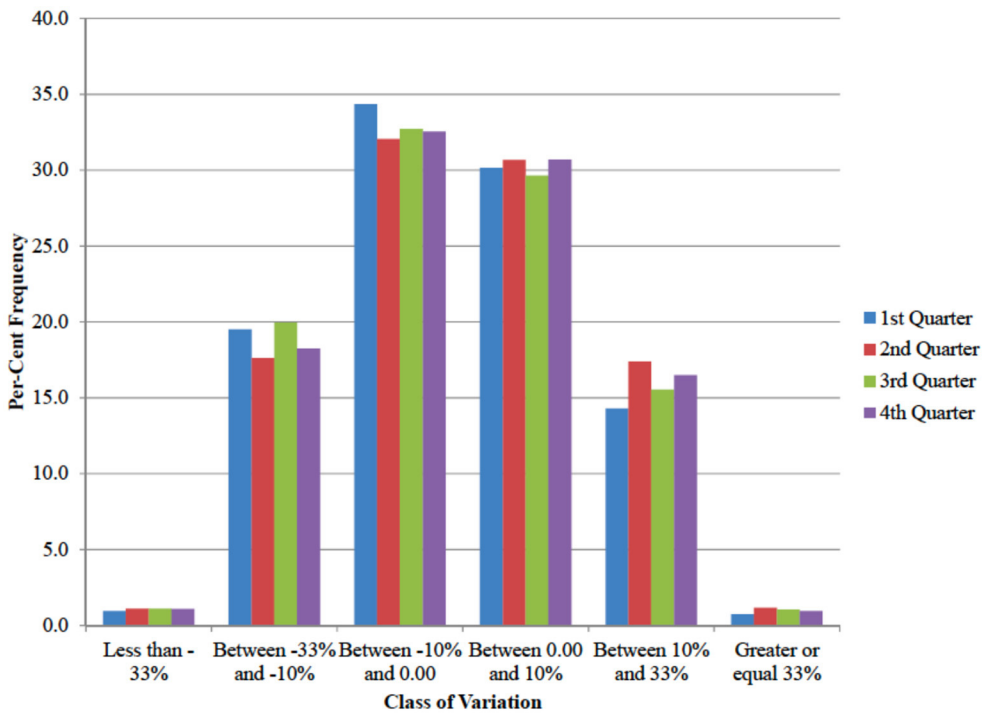

FIGURE 8 | Distribution of households by class of change in expenditure share of fresh fruit and vegetable over all fruit and vegetables. (percentage frequencies, quarters 2020 compared to same quarter in 2019).

TABLE 4 | Descriptive statistics.

Description	Variables	Units	Bef. Covid-19		After Covid-19	
			Mean	St. Dev	Mean	St. Dev
Per Capita Expenditure for Fresh F&V	PCEX_FFV	£	37.51	32.74	41.47	35.50
Per Capita Expenditure for Processed F&V	PCEX_PFV	£	26.35	19.12	29.76	21.57
Expenditure for Fresh F&V/ Total F&V Exp.	SHARE_F	Share	0.55	0.18	0.55	0.18
Per Capita Total Grocery Expenditure	PCEX_TOT	£	366.38	204.04	418.88	230.40
Exp. Convenience Stores/Total Grocery Exp.	CONV	Share	0.07	0.12	0.07	0.13
Exp. Discount Stores /Total Grocery Exp.	DISC	Share	0.20	0.26	0.20	0.27
Exp. Large Stores / /Total Grocery Exp.	LARGE	Share	0.58	0.31	0.54	0.33
Exp. from CB & Other Stores/Total Gr. Exp.	OTHER	Share	0.07	0.09	0.06	0.10
Online Expenditure/Total Grocery Exp.	ONLINE	Share	0.08	0.22	0.13	0.28
Age of Primary Shopper	AGE	Years	52.91	13.17	52.91	13.17
Sex of Primary Shopper (1 = male)	SEX	Binary	0.27	0.44	0.27	0.44
Number of Children in the Household	NCH	Number	0.49	0.88	0.49	0.88
Number of Adults in the Household	NAD	Number	2.20	2.73	2.20	2.73

Before Covid-19 period ranges from first quarter 2019 to first quarter 2020 (included), After Covid-19 period ranges from second quarter 2020 to fourth quarter 2020.

capita expenditure for all grocery goods (PCEX_TOT) and to the share of total grocery expenditure by store type (CONV, DISC, LARGE and OTHER) have been added to the model in order to test the hypothesis as described in the methodological section.

Measuring Existence and Magnitude of Stay-Home Lifestyle Response

The regression confirmed that the expenditure for both types of fruit and vegetables increase with the total expenditure for grocery. Before COVID-19, an additional pound of grocery expenditure resulted in 8 pence increase in fresh fruit and vegetables expenditure and in 6 pence increase in processed fruit and vegetables. The figures are roughly consistent with the observed 18% share of the grocery budget for both categories (**Figure 5**). After COVID-19, the marginal effect of an increase in grocery expenditure decreased by a small but statistically significant amount (0.3 and 0.2 pence for Fresh and Processed Fruit and Vegetables, respectively).

An increase of £1 in grocery expenditure has a negative but extremely small effect in the share of fresh fruit and vegetables on total fruit and vegetables (**Table 6** using regression 3). The effect did not change after COVID-19. Based on the regression results, we can conclude that a limited effect of Stay-Home Lifestyle response was detected.

Measuring Existence and Magnitude of the Pandemic Shopping Response

The choice of store type has a statistically significant impact on the expenditure for fruit and vegetables. The coefficients can be interpreted as the effect on fruit and vegetables expenditure of increasing the share of grocery expenditure in the store type by 1, while reducing the share of online grocery expenditure by the same amount. Note that because a linear model was used, the opposite of the coefficient estimate provides an estimation of the change in fruit and vegetables expenditure due to an increase in online expenditure share obtained reducing the expenditure in a given store type by the same amount.

Increase in online purchase is associated with an increase in the expenditure for fruit and vegetables, with the only exception of the case of fresh products and a reduction in expenditure at discount stores. The COVID-19 outbreak did not affect the results for processed fruit and vegetables and had a limited effect on fresh products. In general, increasing in online purchase is associated with decrease in the expenditure share of fresh fruit and vegetables, relative to processed ones (**Table 5** using regression 3). COVID-19 did not alter this trend. Based on the regression results we concluded that Pandemic Shopping response affected the expenditure for fruit and vegetables.

Measuring Existence and Magnitude of the Mood and Attitude Response

Table 7 reports the results of the comparison of the coefficients of seasonal binary variables. Each 2020 variable has been compared with the same quarter in 2019 in order to identify changes after the Covid-19 outbreak that were not captured by Lifestyle or Pandemic Shopping Responses. The regressions found a positive effect on the per-capita expenditure for Processed Fruit and Vegetables ranging from 2.2 pounds in summer (Q3) to almost 3 pounds in fall (Q4). The effect on fresh produce was moderate or insignificant in spring and fall but very large (£8) during fall. As a result of the two combined effect, the 2020 seasonal coefficients in regression 3 (expenditure share) were lower than the 2019 ones in spring and summer and higher in fall. Based on these results, it is possible to conclude that an effect of Mood and Attitude Response was detected.

Finally, the regressions found that elder, female shoppers on average are expected to consume more fresh fruit and vegetables than younger male ones. Number of adults and children are

TABLE 5 | Results of the regressions of per capita expenditure for fresh fruit and vegetables (PCEX_F), per capita expenditure for processed fruit and vegetables (PCEX_P) and share of expenditure for fresh fruit and vegetables on total expenditure for fruit and vegetables (SHARE_F).

		Regression 1 PCEX_F			**Regression 2 PCEX_P**			**Regression 3 SHARE_F**		
		R^2: 0.361 Wald χ^2: 10311.02$^{(***)}$			R^2: 0.407 Wald χ^2: 7591.15$^{(***)}$			R^2: 0.058 Wald χ^2: 6584.78$^{(***)}$		
Description	**Variables**	**Coeff.**	**S.E.**	***P*-value**	**Coeff.**	**S.E.**	***P*-value**	**Coeff.**	**S.E.**	***P*-value**
Per capita total grocery expenditure	PCEX_T	0.080	0.002	0.000$^{(***)}$	0.060	0.001	0.000$^{(***)}$	−0.002	0.000	0.000$^{(***)}$
Exp. convenience stores/total grocery exp.	CONV	−5.761	2.536	0.023$^{(**)}$	−6.551	0.980	0.000$^{(***)}$	1.635	0.907	0.072$^{(*)}$
Exp. discount stores/total grocery exp.	DISC	4.673	0.721	0.000$^{(***)}$	−3.923	0.481	0.000$^{(***)}$	8.497	0.515	0.000$^{(***)}$
Exp. large stores/total grocery exp.	LARGE	−1.491	0.643	0.020$^{(**)}$	−2.416	0.413	0.000$^{(***)}$	1.028	0.418	0.014$^{(**)}$
Exp. from CB & Other Stores/Total Gr. Exp.	OTHER	−18.632	1.608	0.000$^{(***)}$	−10.280	0.867	0.000$^{(***)}$	−6.366	1.021	0.000$^{(***)}$
2 nd Quarter 2019 (binary variable)	$Q2_{19}$	2.102	0.103	0.000$^{(***)}$	−0.606	0.074	0.000$^{(***)}$	1.984	0.082	0.000$^{(***)}$
3 rd Quarter 2019 (binary variable)	$Q3_{19}$	1.308	0.120	0.000$^{(***)}$	−0.924	0.079	0.000$^{(***)}$	1.646	0.089	0.000$^{(***)}$
4 th Quarter 2019 (binary variable)	$Q4_{19}$	−6.387	0.110	0.000$^{(***)}$	−1.373	0.080	0.000$^{(***)}$	−3.088	0.085	0.000$^{(***)}$
Interactions with the indicator (binary variable) *a*	PCEX_T×*a*	−0.003	0.001	0.003$^{(***)}$	−0.002	0.001	0.006$^{(***)}$	0.000	0.000	0.702
identifying the post-COVID-19 periods	CONV×*a*	3.651	1.692	0.031$^{(**)}$	1.510	0.949	0.111	1.113	0.821	0.175
	DISC×*a*	−0.956	0.597	0.109	−0.598	0.418	0.152	−1.024	0.420	0.015$^{(**)}$
	LARGE×*a*	−1.019	0.548	0.063$^{(*)}$	−0.239	0.405	0.555	−0.295	0.367	0.422
	OTHER×*a*	−3.275	1.176	0.005$^{(***)}$	−1.663	0.828	0.045$^{(**)}$	0.367	0.976	0.707
2 nd Quarter 2020 (binary variable)	$Q2_{20}$	3.549	0.621	0.000$^{(***)}$	1.835	0.432	0.000$^{(***)}$	0.334	0.380	0.380
3 rd Quarter 2020 (binary variable)	$Q3_{20}$	1.050	0.619	0.090$^{(*)}$	1.306	0.426	0.002$^{(***)}$	−0.610	0.377	0.105
4 th Quarter 2020 (binary variable)	$Q4_{20}$	1.713	0.648	0.008$^{(***)}$	1.573	0.444	0.000$^{(***)}$	−0.134	0.379	0.723
Age of Primary Shopper	AGE	0.157	0.023	0.000$^{(***)}$	−0.129	0.012	0.000$^{(***)}$	0.198	0.013	0.000$^{(***)}$
Sex of Primary Shopper (1 = male)	SEX	−1.816	0.557	0.001$^{(***)}$	1.219	0.311	0.000$^{(***)}$	−2.538	0.333	0.000$^{(***)}$
Number of children in the household	NCH	−1.510	0.230	0.000$^{(***)}$	−1.043	0.136	0.000$^{(***)}$	−0.173	0.181	0.337
Number of Adults in the Household	NAD	−3.060	0.267	0.000$^{(***)}$	−1.381	0.151	0.000$^{(***)}$	−0.451	0.177	0.011$^{(**)}$
	Constant	11.490	1.800	0.000$^{(***)}$	17.141	1.065	0.000$^{(***)}$	47.777	1.059	0.000$^{(***)}$

Asterisks indicates coefficients that are statistically significant at 90% (*), 95% (**), or 99% (***) confidence level.

TABLE 6 | Expected change in expenditure for fresh and processed fruit and vegetables due to a unit increase in online expenditure share for grocery products and an equal amount reduction in the share of other types of stores (values in £).

	Fresh F&V		**Processed F&V**	
A unit Reduction	**Bef. Covid**	**After Covid**	**Bef. Covid**	**After Covid**
Convenience stores	5.761	2.11$^{(**)}$	6.55	5.04
Discount stores	−4.673	−3.72	3.92	4.52
Large Stores	1.491	2.51$^{(*)}$	2.416	2.66
Other Stores	18.632	21.91$^{(***)}$	10.280	11.94$^{(**)}$

-The difference between before and after Covid-19 is statistically significant at: $^{(*)}$ 90% confidence level, $^{(**)}$ 95% confidence level, $^{(***)}$ 99% confidence level.
-Before Covid-19 period ranges from first quarter 2019 to first quarter 2020 (included), After Covid-19 period ranges from second quarter 2020 to fourth quarter 2020.
-Figures in the table report the expected (average) change in expenditure due to a change in a household choice of shopping type. The results simulate the hypothetical effect on fruit and vegetable consumption of changing the usual shopping outlets because of the pandemic.

negatively associated with expenditure for both types of fruit and vegetables, with larger households having on average lower expenditure share for fresh products.

DISCUSSION

The objective of this paper is to measure the impact of COVID-19 on the purchases of fruit and vegetables for at home consumption by UK households and to identify the driving factors the response.

Descriptive statistics from the UK sample data showed that the expenditure for at-home consumption of fruit and vegetables increased after the COVID-19 outbreak (**Table 3**). The 95% confidence interval of the percentage increase in expenditure ranged between 7.7 and 11.1% for fresh fruit and vegetables and between 12.0 and 15.6% for processed fruit and vegetables. The different rate of increase resulted in slight decrease of the sample

TABLE 7 | Differences in estimated coefficients of seasonal effects before and after Covid-19.

Comparison	Regression 1 PCEX_F	Regression 2 PCEX_P	Regression 3 SHARE_F
$Q2_{20}$-$Q2_{19}$	$1.45^{(**)}$	$2.44^{(***)}$	$-1.65^{(***)}$
$Q3_{20}$-$Q3_{19}$	−0.26	$2.23^{(***)}$	$-2.26^{(***)}$
$Q4_{20}$-$Q4_{19}$	$8.10^{(***)}$	$2.95^{(***)}$	$2.95^{(***)}$

The difference is statistically significant in a pairwise χ^2 test on equality of coefficients at: $^{(**)}$ 95% confidence level, $^{(***)}$ 99% confidence level.

expenditure share for fresh produce over the total expenditure for fruit and vegetables. The point estimate of the variation was−0.4% (from 55.4 before COVID-19 to 55.0% after COVID-19). However, this difference was statistically significant only at 90% confidence level and there is no strong statistical evidence supporting a change in the composition of the basket.

The relatively small average variations are the result of heterogeneous trends heading in conflicting directions. The analysis of household data showed that individual changes in fruit and vegetables purchase may be large, even if on the aggregate expenditure is relatively stable.

The At-Home Lifestyle response (measured as changes in total grocery expenditure) was the main driver of the changes in expenditure. Changes in per capita expenditure for all grocery products explain 46% of the variation in the per capita expenditure for at home consumption of fruit and vegetables alone.

On average, before COVID-19 for each additional £1 of grocery expenditure there was 8 pence increase in expenditure for fresh fruit and vegetables produce and 6 pence increase for processed fruit and vegetables. However, after COVID-19 there was a small but statistically significant reduction in both marginal effects. This result implies that stay-home habit led on average to a lower-than-expected change in the dependent variables. Based on the available data, the increases in per capita expenditure for fresh and processed fruit and vegetables were 3.75 and 3.3% lower than what they would be expected based on pre-COVID-19 trends, respectively.

Pandemic Shopping response to COVID-19, on average, helped consumers dealing with limitations to mobility, at least partially. By shopping online, UK consumers were able to keep their expenditure for fruit and vegetables. The overall effect is consistent with an acceleration of the pre-COVID-19 trend. More households buy online because of the pandemic, but once they log on the website their purchasing behavior is similar to the pre-COVID-19 online shoppers. A partial exception might concern the increasing online purchase of fresh fruit and vegetables, but statistical evidence is mixed in this regard. An important exception to the general trend is that substituting purchases at discount stores with online shopping is expected to reduce per capita expenditure of fresh fruit and vegetables. This result suggests that price-sensitive consumers might have a different approach to online shopping of fruit and vegetables than others.

A set of binary variables identifying each quarter after COVID-19 was used to measure the effects of Mood and Attitude response of UK consumers. The systematic effect that was not explained by the Lifestyle and Pandemic Shopping responses or by other variables in the model was attributed to the consequences of COVID-19 psychological pressure on consumers. Based on the results from **Table 7**, the estimates of the effect of this Response type range between 8 and 11% of average per capita expenditure before COVID-19.

The effect was almost constant over the entire study period as far as processed fruit and vegetables are concerned. The result is consistent with a hoarding effect, leading consumers to increase their expenditure for non-perishable products. In this way, consumers stockpile products to cover for possible future shortage.

Instead, in the case of fresh fruit and vegetables, effect was small or insignificant during the first two quarters after the pandemic outbreak and very large (£8) in fall 2020. The result might be driven by health concerns as the second wave of contagion was approaching, but more research is needed in this regard.

The increase in online shopping was associated with increases in per capita expenditure for fruit and vegetables. This result is of particular importance, given the concerns that movement limitations during the pandemic may have negative consequences on nutrition. However, the positive effect of online purchases was stronger in the case of expenditure for processed fruit and vegetables.

Finally, we acknowledge that the study has three main limitations. Firstly, it considers only at-home consumption. Therefore, it is not possible to compute the actual change in consumers' diet because away from home consumption before COVID-19 was not observed. Secondly, the dataset used quarterly data and was unable to break the time period according to the exact developments in the pandemic emergency. For example, the outbreak happened in the UK during February 2020 and most of the containment measures were adopted in March. This implies that the first quarter 2020 included data both before and after COVID-19, making interpretation of the results difficult. More comprehensive and detailed datasets may be used in future research to confirm the results. Finally, predictive power of the regressions of the share of fresh fruit and vegetable on total fruit and vegetables expenditure (**Table 5**) is very low. This result suggests special caution in the interpretation of the factors affecting the substitution between fresh and processed products.

DATA AVAILABILITY STATEMENT

The data analyzed in this study is subject to the following licenses/restrictions: The Kantar Worldpanel dataset is a proprietorial dataset and cannot be made available but we have included descriptive statistics in the Annex. Requests to access these datasets should be directed to cesar.revoredo@sruc.ac.uk.

ETHICS STATEMENT

Ethical approval on human participants was not provided for this study because the data used in this research were secondary data (home scan panel data). The researchers had no influence on the manner in which the data were collected.

AUTHOR CONTRIBUTIONS

CR-G: conceptualization, data preparation, investigation, visualization, formal analysis, writing—original draft, and writing—review and editing. CR: conceptualization, investigation, writing—original draft, and writing—review and editing. ET: conceptualization, investigation, and formal analysis. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fnut.2022.847996/full#supplementary-material

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Assessment of Dietary and Lifestyle Responses After COVID-19 Vaccine Availability in Selected Arab Countries

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Background: The COVID-19 pandemic has been consistently associated with unhealthy lifestyle behaviors and dietary practices. This study aimed to assess the dietary and lifestyle behaviors of adults after COVID-19 vaccine availability and their attitude toward the vaccine in selected Arab countries.

Methods: A cross-sectional survey-based study was conducted between October 2021 and December 2021 using Google Forms (n = 2259). A multi-component questionnaire was used to collect socio-demographic characteristics, attitudes toward the COVID-19 vaccine, and behavioral, dietary, and lifestyle responses after easing the restriction. Participants were given a score based on the sum of positive dietary and lifestyle changes. The generalized linear models were used to identify the association between positive dietary and lifestyle changes score and sociodemographic characteristics.

Results: Weight gain during the pandemic was reported by 39.5% of the participants, 36.1% reported ever getting infected with the COVID-19 virus, and 85% received at least one dose of the vaccine. The key adverse reactions of the COVID-19 vaccine were fatigue, headache, and joint pain, and the main reason for vaccination was protection against infection. Most participants were concerned about the vaccine side effects (45.8%) and inadequate testing (50.7%). After easing of restriction, 54.3% of the participants reduced the frequency of disinfecting objects, and 58.3% joined social events. Most dietary and lifestyle behaviors remained unchanged after vaccine availability but there was an increase in the time spent behind the screen for work (50.1%) and entertainment (42.9%). The results of the multivariate regression analyses

revealed that older participants ($p = 0.001$), those with higher education ($p = 0.010$), and those working from home ($p = 0.040$) were more likely to have higher positive dietary and lifestyle changes scores.

Conclusion: Although most participants were concerned about vaccine safety, low vaccine hesitancy rates were observed among the study sample. The availability of the COVID-19 vaccines resulted in loosening some of the safety social measures among Arab adults but the negative impact of the pandemic on dietary and lifestyle behaviors remained unaltered.

Keywords: Arab countries, COVID-19 pandemic, COVID-19 vaccination, dietary habits, lifestyle behaviors

INTRODUCTION

The novel coronavirus 2019 (COVID-19) pandemic caused by the SARS-CoV-2 virus is far from resolved as the virus is constantly changing through mutations, and new variants have been detected across the globe (1). More transmissible variants of the virus, those that may increase disease severity, or may decrease vaccine effectiveness are referred to as variants of concern (VOCs) (2). Since December 2020, five VOCs have been detected including Alpha, Beta, Gamma, Delta, and Omicron (1). Thus, the number of new cases is still surging around the globe posing an increased risk to global public health. As the effectiveness of the vaccines against VOC is still under investigation (3), public health authorities, such as the World Health Organization (WHO) encourage countries to continue implementing the precautious existing public health and social measures.

In the early stages of the COVID-19 pandemic, countries were forced to act promptly due to the absence of a cure or a vaccine, and apply restrictions and safety measures to contain the spread of the virus by focusing on changing public behavior (4). Preventive non-pharmaceutical interventions (NPIs) varied from mandating face masks and social distancing to tougher measures including complete lockdowns, isolation of the infected population, teleworking, and virtual education. Several countries in the Middle East enforced complete or partial lockdowns by fines and penalties such as the United Arab Emirates and Jordan (5). Although these strict measures were effective in preventing and delaying the spread of the virus, they entail enormous socio-economic costs and have negatively impacted the quality of life (6). Our previous research in the Middle East and North Africa (MENA) region revealed that lockdowns were associated with a variety of negative lifestyle and dietary habits, physical inactivity, high screen time, sleep disturbances, and anxious psychological feelings among adults (7–10).

Vaccination against COVID-19 is one of the most effective ways to contain the infection. By December 2020, the WHO approved the use of Pfizer/BioNTech for emergency (11) and other vaccines including AstraZeneca/Oxford, Johnson and Johnson, Moderna, Sinopharm, Sinovac, and COVAXIN were deemed safe and efficient by the WHO during 2021 (12). Within 1 year, around 8.8 billion vaccine doses were administered globally and 48.3% of the world population has been fully vaccinated against COVID-19 (13). In the MENA region, up to 91% of the population in the United Arab Emirates, 38% in Jordan, 29% in Palestinian territories, and 28% in Lebanon were fully vaccinated against COVID-19 by the end of 2021 (14). With the increasing vaccination rates, countries were able to gradually lift some of the NPIs including lockdowns, travel bans, and capacity restrictions on gatherings (15). It was believed that adherence to preventive measures such as hygiene behaviors might be reduced after easing the restrictions and the availability of the vaccine, while adherence to social distancing and masking may remain high (16). However, behavioral and lifestyle changes after the availability of the vaccine have not been investigated in Arab countries yet.

Apart from the Arab Gulf countries, vaccine rates in the MENA region remain low (13). A recent systematic review found low acceptance rates of the COVID-19 vaccines in the Middle East (17): with Lebanon (21%) (18), Jordan (37.4%) (19), United Arab Emirates (60%) (20), and Palestine territories (63%) (21). Thus, vaccine hesitancy is posing crucial challenges in controlling the COVID-19 pandemic. Several studies investigated vaccine acceptability among the public and found that the most common factors for willingness to get the vaccine were self-protection and stopping the spread of the virus (22). In the United Arab Emirates and Jordan, the main motivators for vaccine acceptability included the safety and efficacy of the vaccine, followed by a low risk of side effects, and higher overall protection (23, 24). A study among university students in Lebanon revealed that a lower level of knowledge about the COVID-19 disease was associated with higher vaccine hesitancy (25). With numerous conspiracies about the vaccine on social media platforms, it is critical to investigate attitudes toward the vaccine and the reasons behind the willingness to get vaccinated.

Since the onset of the COVID-19 pandemic, numerous studies have evaluated its impact on dietary and lifestyle behaviors globally (26, 27) and in Arab countries (9, 28–31). In Canada, a quarter of participants reported an increase in the consumption of junk food during the early stage of the pandemic (32). A recent review has indicated an increase in the consumption of unhealthy foods such as fried food, sugar-added drinks, and processed meat during home confinement while consumption of fruit and vegetable was reduced (33). In the United Arab Emirates, results suggested an increased food intake, weight gain, higher smoking rate, sedentary time, and sleep disturbances (28, 29). Similarly, in Lebanon, unhealthy eating habits were

prevalent among adults including low intake of water, fruits, and vegetables (9). Moreover, adults in Jordan and Palestinian territories reported increased consumption of meals and snacks during the COVID-19 pandemic (30, 31).

However, most studies evaluating the impact of the pandemic on eating habits were conducted during the early stages of the pandemic and lockdowns. A longitudinal study in the United Kingdom suggested fluctuations in dietary habits during the first year of the pandemic with a persistent decrease in the consumption of fruits and vegetables (34). Limited data is available on the dietary changes and lifestyle behaviors that might have been retained after the availability of the vaccine and relaxation of NPIs. Moreover, it would be important to investigate whether people have gained new habits during the pandemic that are sustainable in the future. Therefore, this study aims to assess the dietary and lifestyle responses after COVID-19 vaccine availability and to ascertain attitudes toward the vaccine in selected Arab countries.

TABLE 1 | Demographic breakdown of surveyed participants (*n* = 2259).

Characteristics	
Age (years), mean (SD)	31.1 (12.6)
Sex, *n* (%)	
Male	535 (23.7)
Female	1,724 (76.3)
Marital status, *n* (%)	
Married	1,012 (44.8)
Single	1,189 (52.6)
Divorced	40 (1.8)
Widowed	18 (0.8)
Education level, *n* (%)	
Less than high school	64 (2.8)
High school	217 (9.6)
College/Diploma	317 (14.0)
Bachelor's degree	1,285 (56.9)
Higher than bachelor's degree	376 (16.6)
Employment status, *n* (%)	
Full-time	761 (33.7)
Part-time	123 (5.4)
Self-employed	153 (6.8)
Student	667 (29.5)
Unemployed	495 (21.9)
Retired	60 (2.7)
Working/studying from home, *n* (%)	
Yes	711 (31.5)
No	1,334 (59.1)
Not applicable	214 (9.5)
Weight change during the pandemic, *n* (%)	
Lost weight	451 (20)
Gained weight	893 (39.5)
Maintained weight	915 (40.5)
Have chronic disease, *n* (%)	
Yes	244 (10.8)
No	2,015 (89.2
Have ever been infected by the COVID-19 virus, *n* (%)	
Yes	815 (36.1)
No	1,444 (63.9)
Received the COVID-19 vaccine, *n* (%)	
Yes (≥2-doses)	1,753 (77.6)
Yes (1-dose)	178 (7.9)
No (but planning to take it)	149 (6.6)
No (I do not want to take it)	179 (7.9)
Country of residence, *n* (%)	
United Arab Emirates	530 (23.5)
Jordan	517 (22.9)
Lebanon	586 (25.9)
Palestine territories	626 (27.7)

Values represent frequencies and percentages [n (%)] or mean and standard deviation [mean (SD)].

MATERIALS AND METHODS

Study Design

This cross-sectional survey-based study was conducted in selected Arab countries between October 2021 and December 2021. A convenience sample approach was adopted where adults from the United Arab Emirates, Lebanon, Palestine territories, and Jordan were invited to participate. A web link to the online survey was disseminated *via* e-mail invitations and social media platforms, e.g., LinkedIn™, Facebook™, and WhatsApp™. An information sheet explaining the objective and study protocol was offered as the first page of the survey, and participants were required to consent and verify their age and country of residence before proceeding to the questionnaire. To reduce potential sampling bias, participants were encouraged to pass on the questionnaire to a maximum of three individuals from different households.

This study was performed in compliance with the ethical code for web-based research (35) and in line with principles presented in the Declaration of Helsinki. The study protocol received Ethical Approval from the University of Sharjah Research Ethics Committee (Ref: REC-21-10-27-1) and the Institutional Review Board of the Jordan University of Science and Technology (Ref.: 33/142/2021).

Participants

The criterion for participation in the study was living in the United Arab Emirates, Lebanon, Palestine territories, or Jordan and aged 18 years or older. There were no restrictions on age, gender, education, vaccination, or type of COVID-19 vaccine.

A total of 2,259 participants completed the questionnaire from four Arab countries: Jordan (22.9%), Lebanon (25.9%), Palestine territories (27.7%), and United Arab Emirates (23.5%). The data were collected and analyzed anonymously to maintain confidentiality, and electronic informed consent was obtained from all participants. Participants were not rewarded for completing the online survey and were free to withdraw at any point. Only completed questionnaires were saved into the system and were included in the analysis of the study.

Questionnaire

A multicomponent, self-administered online questionnaire was developed using Google Forms in English and Arabic. The

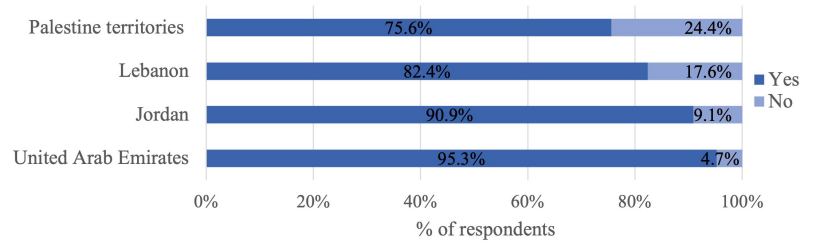

FIGURE 1 | Percentage of participants who have received at least one dose by country (*n* = 2295).

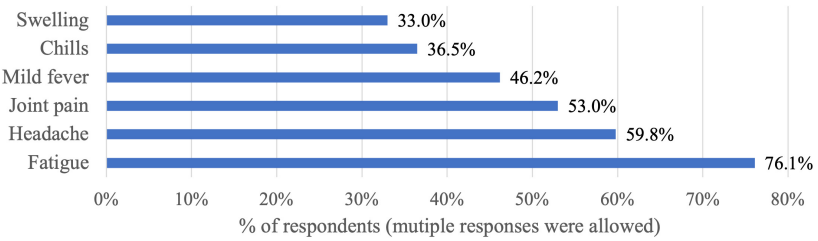

FIGURE 2 | The main stated adverse reactions after receiving the COVID-19 vaccine (*n* = 1931).

first draft of the questionnaire was developed by researchers at the University of Sharjah based on relevant literature and our previous study in the MENA region (7, 36). The questions were then reviewed and validated by a panel of experts for content relevance.

The questionnaire was originally developed in the English language and forward translated into Arabic by a bilingual translation expert. It was then backward translated into English by a different bilingual translation expert. The questionnaire required an estimated time of 10–15 min to complete. It was pilot tested with 30 people in the United Arab Emirates, Lebanon, and Jordan, to assess the clarity of the questions, and no significant modifications were required. The pilot-testing data was not included in the results of the study. The internal consistency of the questionnaire was evaluated by calculating the Cronbach's α coefficient. The questionnaire in this study was shown to be a reliable instrument as indicated by a Cronbach's alpha of 0.81, which suggests a good internal consistency (37).

The questionnaire was divided into four sections: (Section 1) Socio-demographic characteristics (11 items): age, sex, marital status, education level, employment status, work or study setting, weight change during the pandemic, medical history, previous infection of COVID-19, COVID-19 vaccine status, and country of residence. Those who got vaccinated were further asked about adverse reactions after getting the vaccine and reasons to take the vaccine; (Section 2) Attitudes toward the COVID-19 vaccine (9 items): the seriousness of the COVID-19 pandemic, understandability, feeling of control, vulnerable groups and their risk of infection, COVID-19 vaccine safety and efficacy questions; (Section 3) Behavioral responses after easing the restriction (8 items): avoidance of places and activities that pose a risk of infection and compliance with recommended activities to decrease the risk of infection; (Section 4) Dietary and lifestyle changes after easing the restrictions (18 items): meal type, food intake, intake of immune-boosting foods or supplements, number of meals per day, food choices, number of meals consumed with family or friends, breakfast consumption, skipping meals, snacking, water intake, physical activity, screen time for work/leisure, sleep quality and energy level. The full version of the questionnaire can be found in the **Supplementary Material**.

Data Analysis

Categorical variables are presented as frequencies and percentages and continuous variables were presented as means (M) and standard deviations (SD). The Chi-Square test (χ^2) test was used to examine attitude differences by country. Each participant was given a score based on the sum of positive dietary and lifestyle changes. Favorable dietary and lifestyle changes included: increased consumption of fruits and vegetables (vs. same or decreased), decreased consumption of fast foods (vs. same or increased), decreased consumption of fried foods (vs. same or increased), increased number of meals consumed with family or friends (vs. same or decreased), consume breakfast daily, do not skip meals, drinking ≥2 l of water per day, increased physical activity (vs. same or decreased), decreased screen time for entertainment (vs. same or increased), improved sleep quality (vs. same or worsened), and improved level of energy (vs. same or worsened). Positive dietary and lifestyle changes score was calculated whereby participants will receive 0–11 points based on the number of favorable dietary and lifestyle changes they reported. Each variable was counted as 1 point toward the overall score and the sum was calculated for each participant. A higher score indicated a high number of positive dietary and lifestyle changes. The generalized linear model analyses were carried out to investigate the association

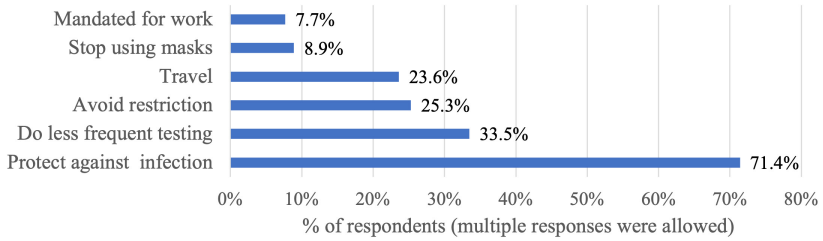

FIGURE 3 | The motivators to get COVID-19 vaccination (n = 1931).

TABLE 2 | Attitude toward the COVID-19 vaccine (n = 2259).

Attitudes	*n* (%)
I think the current COVID-19 situation is serious.	
Agree	1,013 (44.8)
Neutral	915 (40.5)
Disagree	331 (14.7)
I do not understand what is happening with the COVID-19 pandemic.	
Agree	610 (27.0)
Neutral	831 (36.8)
Disagree	818 (36.2)
I think that whether I get the coronavirus or not is out of my control	
Agree	1,140 (50.5)
Neutral	680 (30.1)
Disagree	439 (19.4)
In my opinion, people are still going to be catching the coronavirus	
Agree	1,909 (84.5)
Neutral	147 (6.5)
Disagree	203 (9.0)
Only people who have underlying medical problems should be vaccinated	
Agree	269 (11.9)
Neutral	372 (16.5)
Disagree	1,618 (71.6)
The COVID-19 vaccine will protect me from coronavirus infection.	
Agree	776 (34.4)
Neutral	766 (33.9)
Disagree	717 (31.7)
I am concerned about the side effects of the COVID-19 vaccine.	
Agree	1,035 (45.8)
Neutral	688 (30.5)
Disagree	536 (23.7)
I am concerned that the vaccine has not been tested adequately.	
Agree	1,146 (50.7)
Neutral	688 (30.5)
Disagree	425 (18.8)
The COVID-19 vaccine will stop the spread of coronavirus.	
Agree	667 (29.5)
Neutral	844 (37.4)
Disagree	748 (33.1)

between the positive dietary and lifestyle changes score and sociodemographic characteristics. The variables entered in the final multivariate regression model were selected with the use of a univariate general linear model, with the use of a cut-off value of $p < 0.05$ to be included. Statistical analyses were carried out using the Statistical Package for the Social Sciences (SPSS Inc., IBM, Chicago, IL, United States) version 26.0. A p-value of less than 0.05 was considered statistically significant. As the data was collected through a web link and all questions were required, no missing values were recorded.

RESULTS

Demographic Characteristics

Key demographic variables of the study population are presented in **Table 1**. Participants' ages ranged from 18 to 83 years (M = 31.1, SD = 12.6), with 23.7% males. Most surveyed individuals were single (52.6%), completed a university degree (56.9%), worked full-time (33.7%), and were not working/studying from home (59.1%).

Over one-third of the respondents reported weight gain during the pandemic (39.5%), while 20% lost weight, and 40.5% maintained weight. Only 11% of the respondents had chronic conditions, and 36.1% reported ever getting infected with the COVID-19 virus. Over 85% received at least one dose of the vaccine, 77.6% received two or more doses of the vaccine, and only 7.9% had no desire to get vaccinated.

As shown in **Figure 1**, the highest percentage of participants who received at least one dose of the COVID-19 vaccines was reported in the United Arab Emirates (95.3%), followed by Jordan (90.9%), Lebanon (82.4%), and Palestine territories (75.6%).

Of the participants who received at least one dose of the vaccine, 63.5% reported experiencing adverse reactions. The main adverse reaction was fatigue (76.1%), followed by headache (59.8%), and joint pain (53%), and the least stated side effect was swelling of the arm (33%) (**Figure 2**).

The participants were asked about the reasons behind getting the vaccine against COVID-19 and varied responses were obtained (**Figure 3**). The top reported reasons for vaccination were to protect against infection (71.4%), to get tested less frequently (33.5%), and to avoid restrictions (25.3%). The least selected reason was that the vaccine is mandated for work purposes (7.7%).

Attitude Toward the COVID-19 Vaccine

Most of the participants (44.8%) believe the current COVID-19 situation is serious and 84.5% of the participants were aware

TABLE 3 | Behavioral responses after easing the restriction by country (*n* = 2259).

After easing the restriction, I have	Total (*n* = 2259)	United Arab Emirates (*n* = 530)	Jordan (*n* = 517)	Palestine (*n* = 626)	Lebanon (*n* = 586)	χ^2	*p*-value
	n (%)						
Washed my hands less often than usual with soap and water	595 (26.3)	155 (29.2)	122 (23.6)	167 (26.7)	151 (25.8)	4.45	0.217
Used alcoholic hand gel less than usual	1062 (47.0)	227 (42.8)	217 (42.0)	366 (58.5)	252 (43.0)	45.74	<0.001
Reduced the amount I clean or disinfect objects that I might touch	1226 (54.3)	275 (51.9)	285 (55.1)	351 (56.1)	315 (53.8)	2.25	0.523
Been in crowded places generally	994 (44.0)	214 (40.4)	170 (32.9)	311 (49.7)	299 (51.0)	48.69	<0.001
Increased the amount I use public transport	660 (29.2)	98 (18.5)	100 (19.3)	287 (45.8)	175 (29.9)	137.69	<0.001
Joined more social events, such as meeting friends, or eating out	1316 (58.3)	317 (59.8)	260 (50.3)	370 (59.1)	369 (63.0)	19.56	<0.001
Increased the amount I go into shops	1105 (48.9)	284 (53.6)	197 (38.1)	316 (50.5)	308 (52.6)	32.53	<0.001
Sent one or more of my children to school or pre-school	971 (43.0)	256 (48.3)	241 (46.6)	261 (41.7)	213 (36.3)	19.85	<0.001

Values represent frequencies and percentages [n (%)] of people of answered yes, χ^2, chi-square; P-values based on a = 0.05 level of significance following chi-square test.

that the pandemic is far from being over (**Table 2**). Most of the participants reported that not only those who have underlying medical problems should be vaccinated (71.6%). However, the majority were concerned about the side effects of the COVID-19 vaccine (45.8%) and that the vaccine has not been tested adequately (50.7%).

Behavioral Responses After Easing the Restriction

Safety behaviors after vaccine availability and relaxation of restrictions are presented in **Table 3**. Fewer than one-third of the participants reported washing their hands less often (26.3%) and increased their use of public transportation (29.2%). More than half of the sample reduced the frequency of disinfecting objects (54.3%) and joined social events (58.3%). Participants from Palestine were more likely to reduce the use of sanitizers and increase the use of public transportation ($\chi^2 = 45.74$, $p < 0.001$). Whereas those living in Lebanon were more likely to be in crowded places and join social events ($\chi^2 = 48.69$, $\chi^2 = 19.56$, respectively, $p < 0.001$). Participants residing in the United Arab Emirates reported going shopping in stores more than before and sending their children to school or pre-school ($\chi^2 = 32.53$, $\chi^2 = 19.85$, respectively, $p < 0.001$).

Dietary and Lifestyle Changes After Easing the Restriction

Table 4 presents a description of dietary and lifestyle behaviors after easing the restriction among the study population. Most of the participants consumed mainly homemade meals (88.6%). For most of the dietary and lifestyle behaviors, the majority of participants reported no change: food intake (56.9%), vitamin-rich food intake (59.6%), supplement intake (60.3%), number of meals per day (66.3%), consumption of fruits and vegetables (57.9%), consumption of fast food (45.5%), consumption of fried foods (55.6%), having meals with family and friends (55.0%), physical activity level (43.8%), sleep quality (45.3%), and energy level (40%). However, most participants reported an increase in the time spent behind the screen for work (50.1%) and fun (42.9%).

Table 5 shows the association between sociodemographic confounding factors and positive dietary and lifestyle changes after easing of restrictions. The multivariate regression analyses revealed that older participants (β = 0.015, CI: 0.006–3.381; $p = 0.001$), those with higher education (β = 0.531, CI: 0.185–0.876; $p = 0.010$), and residents of Lebanon (β = 0.223, CI: −0.035–0.481; $p < 0.001$), were more likely to have a higher positive score. On the other hand, the participants who were not working from home or were unemployed (β = −0.170, CI: −0.370–0.030, and β = −0.417, CI: −0.752 to −0.082, respectively) were more likely to have a lower positive score compared to those working from home ($p = 0.040$).

DISCUSSION

The results of the study revealed that over one-third of the study participants reported weight gain since the start of the pandemic and a similar percentage have increased their food intake. A recent systematic review on the effect of the pandemic on body weight concluded that confinements during the pandemic were associated with both weight gain and weight loss (38). The review found that predictors of weight gain during the pandemic were pre-existing overweight status, emotional eating, poor sleep, and decreased physical activity (38). Moreover, data from the MENA region showed that about 40% of the adults were not engaged in physical activity and 63% had sleep disturbances during the pandemic (7). In the current study three-quarters of the participants reported unchanged or decreased physical activity levels and over one-third stated that their sleep quality got worse. This suggests that even after easing restrictions physical activity and sleep quality remained poor and in need of urgent interventions. Physical activity was also shown to decrease the mental health burden related to the COVID-19 pandemic (39). This suggests that weight gain, poor dietary choices, and physical inactivity are not specifically linked to quarantine but rather a subsequent effect of the COVID-19 pandemic. This indicates a strong need for policy action to facilitate making healthier dietary and physical activity choices.

TABLE 4 | Dietary and lifestyle behaviors after easing the restriction (n = 2259).

Characteristics	*n* (%)
Most consumed meals during the week	
Homemade	2,001 (88.6)
Frozen ready-to-eat meals	27 (1.2)
Fast food	132 (5.8)
Restaurants	57 (2.5)
Healthy restaurants	42 (1.9)
Food intake	
Increased	676 (29.9)
Decreased	298 (13.2)
Unchanged	1,285 (56.9)
Vitamin-rich foods intake	
Increased	752 (33.3)
Decreased	160 (7.1)
Unchanged	1,347 (59.6)
Supplements intake	
Increased	732 (32.4)
Decreased	165 (7.3)
Unchanged	1,362 (60.3)
Number of meals per day	
Increased	484 (21.4)
Decreased	277 (12.3)
Unchanged	1,498 (66.3)
Consumption of fruits and vegetables	
Increased*	785 (34.7)
Decreased	165 (7.3)
Unchanged	1,309 (57.9)
Consumption of fast foods	
Increased	373 (16.5)
Decreased*	858 (38.0)
Unchanged	1,028 (45.5)
Consumption of fried foods	
Increased	325 (14.4)
Decreased*	677 (30.0)
Unchanged	1,257 (55.6)
Meals with family and friends	
Increased*	546 (24.2)
Decreased	470 (20.8)
Unchanged	1,243 (55.0)
Consume breakfast daily	
Yes*	1,331 (58.9)
No	928 (41.1)
Skip meals	
Yes	1,169 (51.7)
No*	1,090 (48.3)
Snack between meals	
Yes	1,360 (60.2)
No	899 (39.8)
Water consumption	
Less than eight cups (<2 l)	1,346 (59.6)
Eight cups or more (≥2 l)*	913 (40.4)
Physical activity level	
Increased*	580 (25.7)
Decreased	690 (30.5)
Unchanged	989 (43.8)
Screen time for work	
Increased	1,132 (50.1)
Decreased	311 (13.8)
Unchanged	816 (36.1)
Screen time for entertainment	
Increased	970 (42.9)
Decreased*	479 (21.2)
Unchanged	810 (35.9)
Sleep quality	
Improved*	422 (18.7)
Worsened	813 (36.0)
Unchanged	1,024 (45.3)
Energy level	
Improved*	462 (20.5)
Worsened	893 (39.5)
Unchanged	904 (40.0)

Values represent frequencies and percentages [n (%)].
**Considered as positive changes which were added to calculate the score.*

Attitude Toward the COVID-19 Vaccine

Surprisingly, over 85% of the participants received at least one dose of the vaccine and 78% were fully vaccinated. These rates are higher than the percentage of fully vaccinated populations reported in the same countries according to the WHO reports: United Arab Emirates 91%, Jordan 38%, Palestinian territories 29%, and Lebanon 28% (12). These values also contradict studies from the region on willingness to accept the COVID-19 vaccine (18–20). In Lebanon and Jordan, only a quarter of the participants were willing to take the COVID-19 vaccine when it becomes available (18, 19), whereas in the United Arab Emirates 60% were willing to take the vaccine (20). However, many of these studies were conducted earlier in the pandemic and before the availability of the vaccine. Although participants in the current study were concerned about the side effects of the COVID-19 vaccine and inadequate testing, they had positive attitudes toward it. The highest prevalence of vaccine hesitancy in this study was found in Palestine territories. A study that evaluated factors behind the unwillingness to receive vaccinations in Palestine territories suggested two main reasons for this, lack of vaccine evaluation and the possible long-term side effects (40). Moreover, many individuals obtain vaccine-related information from social media platforms (41). Younger age and lower education were also predictors of vaccine hesitancy (40, 42).

Behavioral Responses After Easing the Restriction

It was hypothesized that vaccine availability and relaxation of restrictions may reduce safety measures among participants. More than half of the sample in this study reduced the frequency of disinfecting objects and joined social events. Although the direct mode of transmission of the COVID-19 virus is *via* person-to-person contact, the transmission may also occur indirectly

TABLE 5 | Association between positive dietary and lifestyle change score and sociodemographic characteristics in the study population (n = 2259).

Parameter	Positive dietary and lifestyle change score					
	Crude β	95% CI	*p*-value	Adjusted β	95% CI	*p*-value
Age (years)	0.012	0.005–0.019	0.001	0.015	0.006–3.381	0.001
Sex (reference: male)			0.239			
Female	−0.126	−0.336–0.084				
Marital status (reference: single)			0.632			
Married	−0.026	−0.207–0.156				
Divorced/Widowed	0.252	−0.318–0.823				
Education level (reference: up to high school)			<0.001			0.010
College/Bachelor's degree	0.293	0.019–0.566		0.339	0.063–0.614	
Higher than bachelor's degree	0.653	0.320–0.987		0.531	0.185–0.876	
Employment status (reference: unemployed)			0.012			0.787
Employed	0.277	0.055–0.50		0.081	−0.0151–0.314	
Student	0.012	−0.231–0.255		0.067	−0.223–0.357	
Working/studying from home (reference: yes)			0.028			0.040
No	−0.161	−0.0358–0.036		−0.170	−0.370–0.030	
Not applicable	−0.437	−0.768 to −0.107		−0.417	−0.752 to −0.082	
Have chronic disease (reference: no)			0.121			
Yes	0.227	−0.060–0.515				
Previous COVID-19 infection (reference: no)			0.069			
Yes	−0.172	−0.358–0.013				
Received vaccine (reference: no)			0.018			0.215
Yes	0.304	0.051–0.557		0.167	−0.097–0.431	
Country of residence (reference: United Arab Emirates)			<0.001			<0.001
Jordan	−0.375	−0.635 to −0.114		−0.403	−0.665 to −0.140	
Palestine territories	−0.471	−0.720 to −0.222		−0.276	−0.537 to −0.014	
Lebanon	0.088	−0.165–0.340		0.223	−0.035–0.481	

CI, confidence interval; P-values based on a = 0.05 level of significance following generalized linear models analyses.

from the objects used by the infected person (43). It is believed that the relative risk of fomite transmission is lower than direct contact or airborne transmission as many factors affect the efficiency of environmental transmission (44). Therefore, it is not clear what percentage of COVID-19 infections are obtained through fomite-mediated transmission. With the identification of new VOCs, the WHO continues to encourage authorities to strengthen public health and social measures as they have shown efficacy in reducing COVID-19 cases, hospitalizations, and deaths (1). These measures include, but are not limited to, frequent hand hygiene, use of masks, avoiding mass gatherings, physical distancing, limiting travel, and avoiding the use of public transportation (45). Moreover, it is predicted that in the absence of such measures, the vaccination program would be too slow to reduce infection and might not reduce the burden of COVID-19 effectively (46). Further studies should investigate the implications of these findings to understand how the relaxation of restrictions may be contributing to the development of new behaviors and habits.

Dietary and Lifestyle Changes After Easing the Restriction

The findings of this study showed that many dietary and lifestyle behaviors were unchanged after easing the restriction. The MENA region is generally experiencing a rise in diet-related disorders (47) which should be attenuated regardless of COVID-19 pandemic or epidemic status. In addition, greater COVID-19 severity was observed among obese patients and patients with chronic diseases (48). On the other hand, an increase in screen time for work and entertainment was reported by most participants. A growing body of literature concerns the increased use of screens and its associated negative health outcomes. A study on families in Canada reported a 74% increase in screen time among mothers, 61% among fathers, and 87% among children (49). Similarly, studies from the MENA region, United Arab Emirates, Lebanon, Palestine, and Jordan have revealed longer screen time during the COVID-19 pandemic (9, 28–31). Excessive screen use is especially harmful to children and adolescents as it was found strongly associated with greater adiposity, unhealthy dietary habits, depressive symptoms, and reduced quality of life (50). Moreover, a recent study reported a significant association between increased screen time and higher consumption of alcohol and sweetened foods among adults (51) which are eventually energy-dense foods.

In the current study, predictors of positive dietary and lifestyle changes after easing of restrictions were older age, higher education, and working from home. Similarly, a study conducted in the United Arab Emirates showed that older adults were less likely to adopt unhealthy dietary and lifestyle habits during the

pandemic (29). Moreover, a study conducted in Spain revealed that older participants and those with higher education levels had higher adherence to healthy dietary habits during the pandemic (52). Furthermore, higher educational level was associated with higher socioeconomic status which was in turn related to a better diet quality (53). The majority of participants in this study reported mainly consuming home-cooked meals. Thus, it is speculated that working from home provided them with more time to prepare home-cooked meals. Similarly, Mexican adults perceived that their dietary habits improved during the pandemic due to working from home and eating homemade food (54). Moreover, a cohort study concluded that eating home-cooked meals was associated with older age, higher socioeconomic status, and not working overtime (55). Given that positive dietary and lifestyle changes were associated with working from home, remote working should be made an option if possible to support healthful pandemic recovery.

Strengths and Limitations

This study has several limitations. Its cross-sectional design does not allow to infer causality.

The use of a self-reported questionnaire could introduce respondent bias or data misreporting. Another potential limitation of the study might be due to the convenience sampling method used to recruit the participants, as it may produce selection bias. Moreover, a higher percentage of females completed the survey which might have impacted the generalizability of the result. Nevertheless, the use of an online survey allowed data collection from different Arab countries and covered a good sample size from each country. It also guaranteed the anonymity of the participants, thus reducing the chance of social desirability bias. The present study offers unique insights about behavioral changes after the availability of the vaccine in selected Arab countries.

CONCLUSION

Overall, our findings revealed a high percentage of vaccination among the participants despite concerns about the safety and inadequate testing of the vaccines against COVID-19. Moreover, most participants joined social gatherings and reduced the frequency of disinfecting after the availability of the COVID-19 vaccines. Most participants reported no change in their dietary and lifestyle behaviors after easing the restrictions. Moreover, the results of the study revealed that older age, higher education, and working from home were associated with positive dietary and lifestyle changes.

Further explorations are needed to examine the subsequent and long-term effects of the pandemic on dietary habits, physical activity, and lifestyle changes, especially after easing restrictions. Moreover, implementing strategies to support healthful lifestyle and eating habits (e.g., working from home, social marketing) is essential to ensure that the negative impact of the pandemic does not remain in the future.

DATA AVAILABILITY STATEMENT

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found below: Figshare: https://doi.org/10.6084/m9.figshare.17890193.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the University of Sharjah Research Ethics Committee (Ref. REC-21-10-27-1) and Institutional Review Board of the Jordan University of Science and Technology (Ref. 33/142/2021). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

LC, TO, and ASA conceptualized and designed the project. LC, TO, ASA, MM, and SS prepared the original protocol. LC, MM, and SS did data management and analysis. LC, TO, MM, AA, DA, HIA, HA, HH, HH, LS, MH, MA, RQ, RS, RA, SS, and ASA collaborated in the overall implementation and data collection of the project. LC, MM, ASA, and SS wrote the original report with input from all co-authors. LC, TO, MM, AA, CH-M, DA, HIA, HA, HH, HH, LS, MH, MA, RQ, RS, RA, SS, and ASA read the report and made suggestions on its content. All authors approved the final manuscript.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fnut.2022.849314/full#supplementary-material

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A Qualitative Study Exploring Management of Food Intake in the United Kingdom During the Coronavirus Pandemic

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The coronavirus pandemic has impacted dietary quality through increased emotional eating and extended time spent at home, as well as instances of panic buying due to uncertainty over food availability. We recruited an opportunistic sample of 40 adults living in the United Kingdom (Female = 25; Mean age = 41.9 years) (SD = 14.4) without any prior history of eating disorders. Semi-structured interviews were conducted in June 2020 and focused on the impacts of the COVID-19 lockdown on eating habits and experiences of panic buying. The data were transcribed and organized using the softwares Otter and Quirkos, respectively. Reflexive thematic analysis identified positive and negative changes to eating habits. Overall, themes highlighted that effective organization was vital to manage food purchases and consumption due to a reduced shopping frequency. However, overconsumption frequently occurred due to boredom and ease of accessing energy dense foods, which had negative implications for weight and body image. After indulging, participants attempted to revert to prior eating habits and adhere to a nutritious diet. Many also expressed the importance of having enough food to feed families, which was often reported as a reason for buying extra supplies. Understanding the long-term impacts of changes to eating habits that account for the novel coronavirus context is required to preserve health and prevent unintended changes to weight.

Keywords: coronavirus pandemic, quarantine, boredom eating, home cooking, panic buying

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INTRODUCTION

The COVID-19 global pandemic disrupted life in various ways, including employment (Blustein and Guarino, 2020), mental health (Xiong et al., 2020) and food supplies (Martin-Neuninger and Ruby, 2020). Imposed quarantine enforcements produced significant stress relating to health concerns (Mattioli et al., 2020). Of interest here were changes in nutrition and eating habits during the pandemic (Robinson et al., 2021), and the potential exacerbation of disordered eating, clinically (Sideli et al., 2021) and in the general population (Tavolacci et al., 2021). Emerging studies have reported increased emotional and binge eating, excessive consumption of energy dense foods and preoccupation with food and body image (Kriaucioniene et al., 2020; López-Moreno et al., 2020; Puhl et al., 2020; Zachary et al., 2020; Robertson et al., 2021). Such findings can be viewed in

terms of coping with emotional distress and managing mental health, which will be discussed in the following sections.

In brief, numerous studies have found significant links between negative emotions (i.e., stress, worry) and the occurrence of emotional eating throughout the pandemic (Mason et al., 2020; Renzo et al., 2020; Scarmozzino and Visioli, 2020; Shen et al., 2020; Bemanian et al., 2021; Usubini et al., 2021). Furthermore, anxiety related to COVID-19 was associated with body dissatisfaction in males and females (Swami et al., 2021). Frequent occurrence of negative affect may increase risk for disordered eating through disruption to exercise routines, comparison of body image through social media and social isolation (Rodgers et al., 2020). Notably, Czepczor-Bernat et al. (2021) found that disordered eating was significantly higher for women who had high COVID-related stress, were overweight and had high body dissatisfaction, in comparison to women with a healthy body weight, no COVID-related stress and low body dissatisfaction. These findings are consistent with the homeostatic theory of obesity (Marks, 2015) which suggests weight gain is linked to various body systems through a "circle of discontent." For instance, the theory suggests reciprocal relationships between (1) body dissatisfaction and negative affect, (2) negative affect and consumption of energy dense foods and beverages, (3) consumption of energy dense foods and overweight/obesity, and (4) overweight/obesity and negative affect.

In addition, prolonged periods at home provided ample eating opportunities, leading to more snacking between main meals (Sidor and Rzymski, 2020). Without meaningful activities or social interaction, eating may be used as an activity to counteract boredom experienced through quarantine periods (Brooks et al., 2020). One implication is that additional snacking increased overall energy intake if other meals were not adjusted accordingly and physical activity levels had altered (Maugeri et al., 2020). Furthermore, evidence suggests that changes to eating behaviours varied across individuals. This was demonstrated by Robinson et al. (2021) who found relationships between a lower diet quality and having a higher BMI, being male and less educated. Similarly, overeating during lockdown was associated with being female, having a previous psychiatric diagnosis, having a higher BMI, and experiencing poorer mental health during the lockdown period. These findings indicate the complexity of how individual differences influence food choices, and their subsequent effect on health.

Collectively, instances of emotional eating (i.e., stress, boredom) present a risk for potential weight gain (Flanagan et al., 2020; Ghosal et al., 2020; Pellegrini M. et al., 2020). A recent systematic review by Khan et al. (2022) indicated that weight gain during the pandemic was prevalent across 7.2 – 74% of participants in comparison to weight loss rates (11.1 – 32%). Notably, weight gain was prevalent in individuals with overweight or obesity. Similarly, Khubchandani et al. (2022) reported that 48% of American adults reported weight gain during the pandemic in a population study. Adding to this, psychological distress, pre-pandemic weight status, having children at home, and the time elapsed since the last weight check were all significant predictors of weight gain over the pandemic (Khubchandani et al., 2022). These studies highlight how disinhibited eating behaviours are exacerbated by quarantine regulations, and are magnified for individuals engaged in weight management. For individuals on a weight loss programme, stress attributed to the pandemic was related to having less time to focus on weight-loss behaviours and increased difficulties with maintaining healthy eating habits (Pellegrini C. A. et al., 2020). Despite the difficulties of the pandemic, some studies have reported success in weight management programmes (Binou et al., 2021; Caldwell et al., 2022). These mixed findings indicate that the occurrence of (un)successful weight management strategies are influenced by variations to the individual's context as a consequence of the pandemic.

Indeed, some studies highlighted positive circumstances of the pandemic which influenced healthier food choices. For instance, Ramachandran and Gill (2020) found more time available meant participants could focus on eating fresh foods. Likewise, consumption of homemade meals and fruit had increased, whereas meals eaten at restaurants or fast-food establishments had decreased (Flanagan et al., 2020). Interestingly, a longitudinal study in Italy indicated that the consumption of energy dense foods and involvement in cooking had improved over the duration of the pandemic (Caso et al., 2022). Despite improvements, some acquired habits were abandoned following the relaxation of quarantine measures. Furthermore, these findings should be interpreted with caution as the sample consisted mainly of social psychology students. Therefore, students may have provided socially desirable responses that underestimated eating habits over the pandemic.

Collectively, studies have primarily reported on the deleterious effects of the pandemic on eating behaviours in both clinical and general populations. Although imposing the strictest lockdown measures was effective for reducing COVID-19 deaths (Davies et al., 2020), this created a challenging dilemma whereby understanding how individuals manage emotional adversity is necessary to prevent further engagement with maladaptive coping strategies and unintended changes to eating behaviour that are enduring beyond COVID-19 (McAtamney et al., 2021).

Another behaviour relevant to food and the pandemic was panic buying (Arafat et al., 2020), described as purchasing groceries in excessive amounts to gain control over situations that stimulate fear and uncertainty (Islam et al., 2021). Prior to COVID-19 the panic buying literature was relatively scarce, but reviewed evidence suggests threat perception is a key feature of panic buying (Yuen et al., 2020). This was reflected in recent research whereby participants with a high perceived risk of contracting coronavirus displayed significantly more intention to hoard food (Long and Khoi, 2020). Furthermore, males and females intended to stockpile when health risks were present, suggesting panic buying is not a gender-specific behaviour (Dammeyer, 2020). According to the theory of planned behaviour, it may be relevant that positive attitudes are allocated to actions which minimize threat and enhance survival during a crisis (Sharma and Sonwalkar, 2013).

Social circumstances also influenced panic buying as positive associations were found between social interactions (i.e., COVID-19 conversations) and panic buying (Yuen et al., 2020). Similarly,

54% of examined media reports during the pandemic highlighted product shortages, stimulating fears over food availability (Arafat et al., 2020). Although evidence for social influences on panic buying is limited, a field study reported observational learning influenced decision making about food (Fishman et al., 2019). At the start of the semester (i.e., higher uncertainty), students chose food stands with the longest line, indicating the use of external information (i.e., others' food choices). One possibility is that panic buying could occur because people believe others are better informed of the situation (Yuen et al., 2020). Alternatively, normative beliefs could explain panic buying, whereby the individual evaluates the appropriateness of their intentions based on other's evaluations of their actions (Ajzen, 1991). Due to the mixed findings, further research is required to determine whether individual perceptions or social interactions are more prominent features of panic buying. Likewise, understanding the transmission of panic buying across populations is essential to prevent future supply-side shocks (Hobbs, 2020) and unnecessary food waste (Caulfield, 2020).

Altogether, these findings have highlighted that emotional responses to the pandemic have significantly affected eating behaviours. Indeed, the pandemic influenced and changed the food environment in ways that may not have previously been experienced (e.g., restricted access to convenience foods, empty shelves in supermarkets). As previously mentioned, although changes to weight were evident in many studies, these effects were not universal. For example, percentages of participants who experienced weight gain throughout the pandemic varied from 25.6% of adult males (Reyes-Olavarría et al., 2020), 41.7% of adolescents (Allabadi et al., 2020), and 66% of adults affected by obesity/overweight with a psychiatric diagnosis (Marchitelli et al., 2020). Therefore, there is a need for studies to understand variation across individuals. The behavioural susceptibility theory of obesity (Carnell and Wardle, 2008) may be particularly useful because the theory considers how psychological (i.e., the rewarding value of food) and biological factors (i.e., responses to hunger and fullness cues) interact with the food environment (i.e., availability of energy dense foods) to influence subsequent food intake and energy balance. This model is pertinent to the pandemic because it acknowledges how people have different susceptibilities which may account for weight variations that seem to result from various changes to both the dietary environment and physical activity (e.g., closure of exercise facilities, increased time spent at home). Although the theory considers the rewarding value of food, it is also necessary to understand the role of emotion in greater detail as findings suggest that the relationship between stress and emotional eating is mediated by emotional dysregulation (Tan and Chow, 2014). Previous studies have predominantly used quantitative methods to understand such factors (Arafat et al., 2020; Ghosal et al., 2020; Long and Khoi, 2020; Zachary et al., 2020). However, these methods may not reflect a breadth of experience because they limit the opportunity for unanticipated responses from participants on the topic of overeating as a method of emotion regulation during the pandemic. Consequently, there is a need for qualitative research to provide insights that enable exploration of the contextual factors that predispose, or buffer from negative eating habits for some individuals but not others.

To summarize, the current research will address the extent to which eating habits have changed during the pandemic due to emotional eating (i.e., anxiety, stress, boredom). Also, the study will explore management of food consumption as a consequence of changes to the food environment brought about by the pandemic (e.g., supermarket shortages, food establishment closures). Finally, the study will explore panic buying that may be driven by social factors or through individual threat perception of the pandemic. This research could inform weight management interventions in terms of emotional eating as a consequence of the pandemic. Understanding the contextual factors that underpin appetitive triggers is essential to prevent further unintended weight gain and continuous reliance on maladaptive coping strategies. For instance, individuals who place high values on food as a reward or use food to soothe emotions can be encouraged to use alternative adaptive coping strategies.

MATERIALS AND METHODS

Participants

We followed guidelines by Malterud et al. (2016) to determine the appropriate sample size. Considering the five suggested aspects of information power, it was established that the (a) aim of the study was broad, (b) sample density was sparse, (c) research was guided by a theoretical framework, (d) quality of dialog was medium, and (e) analysis was exploratory. Furthermore, we decided upon a lower and upper sample size range that would produce a dataset that reflected the richness and complexity of the issues surrounding eating behaviours and the pandemic (Braun and Clarke, 2021). Based upon this information, we estimated that approximately 35 – 40 participants would be adequate to achieve information power. The continuation of interviews was repeatedly assessed throughout the interview process. The primary researcher (TR) was able to strengthen the research dialog by reflecting on the interview process and recognizing which questions were most effective for addressing the research aims. Collectively, the author's social media networks were used as a starting point to recruit participants, yielding a snowball sample. Compensation was not offered for participation. A 100% of participants completed the study and therefore data were analysed for all 40 interviews. Participants were informed that the research aimed to understand their management of food during the coronavirus pandemic, and the impact of lockdown on eating habits. Sampling criteria excluded participants under the age of 18, or anyone with a current or previous eating disorder diagnosis. Participants were informed that no personal details would be included in the study and responses were anonymous. Informed consent was provided through completion of an online questionnaire hosted on Qualtrics[1]. The Swansea University, School of Psychology Research Ethics Committee approved the study.

[1]https://www.qualtrics.com/

Data Collection

As a result of 2020 lockdown restrictions, face-to-face interviewing was not possible, so the video conferencing software Zoom[2] was used. To ensure the connections were confidential, the end-to-end encryption function in Zoom was enabled, meaning that any communication between the interviewer and participant was limited to their personal devices. Interviews took place during the pandemic (i.e., beginning of June 2020), so participants recalled current events or those that had occurred 3 months previously. As illustrated in **Table 1**, interviews were semi-structured and contained a mixture of open and closed questions. When designing the questionnaire, the researchers attempted to consider general aspects of the key topics discussed above and the proposed theories mentioned (i.e., the homeostatic theory of obesity, the theory of planned behaviour and the behavioural susceptibility theory of obesity) were considered. Due to the novelty of the pandemic, the development of questions also reflected pragmatic concerns that were topical at the time of interviews. For instance, growing food at home was found to promote emotional wellbeing (Ambrose et al., 2020), which could have been a protective factor against emotional eating. Therefore, a question that generally asked about whether food growing had been attempted was included. The average interview lasted 34 min, with a range between 16 and 62 min.

[2]https://zoom.us/

TABLE 1 | Interview questions.

Interview questions
When buying food, have you changed how you would typically shop because of the pandemic?
Are you attending the supermarkets more or less?
Do you have to attend more than one supermarket to buy food?
Are you buying food from your local shop as opposed to traveling to your local supermarket?
Have you bought food in greater quantities than normal?
Are you buying food for vulnerable people who can't leave their homes due to social isolation?
Do you worry about not being able to get the food that you need?
Do you plan meals in advance for yourself/family?
How are you feeding yourself/family?
How do you feel when you see other shoppers buying in large quantities?
Have you experienced any barriers that would stop you cooking meals for yourself or you family?
Have you considered growing your own produce?
Are you using the delivery/takeaway service that restaurants offer?
Have financial circumstances impacted ability to eat?
Has your typical diet changed since the pandemic or social isolation?
Do you have to work from home now? If yes, has this affected you eating habits?
Do you have concerns of your weight because of isolation? If yes, are you using any strategies to manage your concerns?
Have your exercise routines altered due to isolation?
Generally, what impact (positive/negative) has social isolation had on your nutrition and exercise?

Procedure

Participants were informed about the study via email and completed an online consent form. One investigator (TR) conducted interviews and reminded participants of the confidentiality of their responses. Furthermore, participants were reassured that they did not have to answer any questions which might cause discomfort. The investigator began interviews by asking about demographic details, followed by questions which explored participants experiences of buying food, meal preparation and the pandemic's impact on diet and exercise. When answering questions, participants were encouraged to apply false names to themselves or family members to maintain confidentiality. Once finished, participants were thanked and emailed a debrief form.

Data Analysis

Interviews were recorded on Zoom and audio files were imported to Otter[3] for data transcription. No notes were taken during interviews and participants were allocated a unique number to conceal identities. All transcripts were uploaded to the software Quirkos for data analysis[4]. Quirkos was used to organize and code transcripts. For instance, words, sentences or paragraphs were highlighted and allocated codes, represented as a bubble on the screen. The bubble became larger as more codes were added, producing an effective visual representation for codes.

Reflexive thematic analysis was utilized (Braun and Clarke, 2006) due to the novelty of the research question (given the pandemic context) and because it has theoretical flexibility, so enables greater versatility for interpretation of patterns (Clarke and Braun, 2017). One researcher (TR) completed data analysis, which is consistent with Braun and Clarke's (2020) recommendations for qualitative research, indicating the researcher's subjectivity does not detract from the quality of data analysis, but rather provides an interpretative reflexive account of the knowledge and experience gained from interviews.

Prior to analysis, transcripts were read multiple times to gain a consensus of participant's experience of food consumption and shopping habits during the initial lockdown. The coding process began by identifying words, sentences and paragraphs that were related to the research question. The process was repeated for all transcripts, whereby similar codes were merged together to form sub-themes. For example, "eating impacted mood" was a code whereby participants experienced negative alterations to mood, typically after overconsumption of energy dense foods. This code was developed into the sub-theme "impact of diet on health." Themes were developed through the interpretation and connection of sub-themes to form a meaningful narrative that answered the research question, and was supported by evidence from participants (Vasimoradi et al., 2016). Codes were reviewed several times to ensure they captured the overall essence of the sub-themes and themes they were developed under. Following Puddephatt et al. (2019), to establish rigour, an independent researcher coded a random selection of statements (10% of full dataset) based on the developed codebook. The primary

[3]https://otter.ai/

[4]https://www.quirkos.com/index.html

researcher (TR) also completed this task. The percentage of agreed statements was determined through dividing the total number of statements by the number of agreed statements. Initial coding agreement was 71%. Follow-up discussions between researchers resolved discrepancies across codes and ensured clarity across themes and sub-themes. The researchers reassessed statements independently and reached an agreement of 95%. Following discussions, codes were updated for the remainder of the data where necessary.

As recommended by Clarke and Braun (2013), we acknowledged any assumptions or values that we hold about the topic that potentially influenced the interpretation of results, see below for a reflexivity statement.

Reflexivity Statement

As a researcher interested in eating behaviours (TR), social media exposure and discussions with others before interviews may have influenced expectations of eating habits. Consequently, I was probing of content concerning the pandemic's impact on weight, prompting more detailed answers. Additionally, I was exposed to empty shelves and the difficulties obtaining basic ingredients (e.g., eggs) in supermarkets. Therefore, I believed the prevalence of stockpiling would be higher and was surprised when some participants revealed no such difficulties. Consequently, I realized the concept of stockpiling is subjective and depends on individual circumstances (e.g., family's shopping habits compared to lone adults).

Also, being a woman, other female participants may be more comfortable discussing weight concerns. Although the sample did not report a history of eating disorders, I acknowledge the discussion of eating habits could produce cautious responses, due to apprehension of evaluation. However, I remained open to responses and mitigated perceptions of judgement by acknowledging experiences from the participant's perspective.

As the last author (LW), I provided supervision to the first author and this was likely influenced by the overarching interests of my research group which is concerned with eating behaviour and weight management, and is situated in a psychology department. Whilst I have conducted and supervised qualitative research previously, my background is predominantly quantitative. Nonetheless, I acknowledge and embrace the differences in epistemological approach, and I altered my supervisory approach accordingly, encouraging reflexivity and understanding of the co-creation of knowledge within the context of the specific study.

RESULTS

The convenience sample consisted of 40 participants; 25 (62.5%) were female. Participant's mean age was 41.9 years (SD = 14.4) and were mainly living in Wales (N = 30). The remaining 10 participants lived in England. **Table 2** contains frequencies and percentages for relationships status, employment status and living circumstances during the first lockdown. Approximately half of participants (55.3%) reported living with children during the first lockdown. Furthermore, the mean age of children was 10.8 years (SD = 4.5) and almost 75% of participants were either married or in a relationship. No participants reported being unemployed and most participants revealed they did not shield during the first lockdown (N = 34). Data were missing for some demographic details, but this has been highlighted in the table by the total responses.

Thematic Analysis of Interview Transcripts

Data analysis produced four key themes and associated sub-themes (see **Table 3**) which are explained in the following paragraphs, supported by quotes from participants.

Theme 1: Environmental Adaptation and Flexibility

Most participants perceived a change to their shopping habits that followed the rules and regulations within supermarkets. Participants felt that they could not "just pop over as and when" [F, 40 years old (yo)] so adapted accordingly. Furthermore, being at home more than usual meant greater flexibility around cooking meals which is considered in the following sub-themes, (1) opportunity for more fresh cooking, (2) unable to access convenience foods, and (3) organisation of food.

Sub-Theme: Opportunity for More Fresh Cooking

As food was consumed "95% at home now" (M, 29 yo), perceptions of eating more freshly cooked meals were reported by most participants. Prior work schedules meant time and energy for cooking was limited. However, being furloughed from work removed the imperative time barrier.

"There's no chance I have any motivation or strength to cook. I would rather just put a pizza in the oven or order it. . .But now I finish earlier. . . I've got more time now during the day to cook for myself instead" (M, 27 yo).

Similarly, participants recognized that their ready meal consumption decreased during the lockdown, as a result of having more time available for meal preparation. "the convenience food, I mean, that's okay if you're busy. . . when I was doing school runs and things like that, so you have limited time, but now I've got all day. . . and it's cheaper" (F, 67 yo).

Some participants cooked "to pass the time" (F, 31 yo), which enabled experimentation with cooking. Likewise, many participants started baking during the pandemic, making desserts, cookies, pizza dough and bread. "I'd be making cakes, brownies, you know there's experimenting with flapjacks. . . just silly little things to keep myself amused" (F, 43 yo).

Sub-Theme: Unable to Access Convenience Foods

The pandemic manifested a change to the food environment by removing access to takeaway restaurants and fast-food chains.

"I would just pop out with the girls and have breakfast or go out for lunch here or grab a McDonald's when you're hungover. But now you can't go anywhere, you can't buy sort of these takeaway and snacky foods" (F, 26 yo).

Despite the reopening of takeaways, a reduced use of facilities was apparent due to uncertainty over contamination. "Sort of like fear of the unknown. . . do they wipe their surfaces properly, are

TABLE 2 | Demographic data of participants.

Demographic variables	Frequency	Percentage
Gender		
Female	25	62.5%
Male	15	37.5%
Total	40	100%
Location		
Wales	30	75%
England	10	25%
Total	40	100%
Age (years)	**Mean**	**SD**
	41.9	14.4
Relationship status	**Frequency**	**Percentage**
Married	15	37.5%
In a relationship	12	30%
Single	9	22.5%
Separated	1	2.5%
Widowed	1	2.5%
Missing data	2	5%
Total	40	100%
Employment status		
Working from home	11	27.5%
Furloughed	10	25%
Working away from home	7	17.5%
Other	5	12.5%
Retired	4	10%
Unable to work due to health/illness	1	2.5%
Missing data	2	5%
Total	40	100%
Were participants a parent or guardian?		
Yes	23	57.5%
No	15	37.5%
Missing data	2	5
Total	40	100%
Did participants have any children living with them during the first lockdown		
Yes	21	52.5%
No	17	42.5%
Missing data	2	5%
Total	40	100%
Age of children living with participants	**Mean**	**SD**
	10.8	4.5
Living arrangements during the first lockdown	**Frequency**	**Percentage**
Family	21	52.5%
Spouse/partner	8	20%
Alone	5	12.5%
Roommates	3	7.5%
Other	1	2.5%
Missing data	2	5%
Total	40	100%
Were participants shielding during the first lockdown		
Yes	4	10%
No	34	85%
Missing data	2	5%
Total	40	100%

TABLE 3 | Themes identified for management of food intake.

Theme	Sub-theme
Environmental adaptation and flexibility	Opportunity for more fresh cooking
	Unable to access convenience foods
	Organised food purchases
	Planning meals in advance
Dietary instability	Using food as a coping mechanism
	Accessibility to calorically dense foods
Eating for nutrition	Impact of diet on health
	Management of calorically dense foods
	Monitoring food intake
Perceptions of panic buying	Reduce risk to health
	Provide for families
	Social influences

they cooking on surfaces that you know, sort of been sprayed with anti-bacterials, but you don't know if they wash their hands" (F, 61 yo). For some, fears lessened throughout the pandemic as the situation improved. "with the COVID number having dropped in Nottingham significantly. I think we felt a bit more confident and a bit more able to take a little more risk" (M, 42 yo).

Some participants suggested that the pandemic influenced their future use of takeaway services as they are "not really missing it to be honest" (F, 40 yo). However, eating out for one participant was a significant part of their social routine which was severely disrupted by quarantine.

"If I met my friends once a week as well for coffee, we'd end up having lunch out... I've missed going out for a coffee and having a chat and a laugh. Yeah, life isn't very happy in lockdown" (F, 76 yo).

This combination of factors suggested participants' overall diet quality had improved by "having that extra bit of nutrition" (F, 31 yo) from cooking fresh at home.

Organised Food Purchases

Considering grocery shopping, many participants stated that they "try to limit the amount of times" (F, 46 yo) they shopped to reduce exposure risk. Some managed this by shopping online, whereas others planned meals in advance. Also, shopping lists provided structure to supermarket visits as participants organised groceries around supplies at home, ensuring they had enough food until the next designated visit. "I was more focused on what I needed to get; I took a list. You could get it instead of just dawdling through, it was more like get in get out" (F, 27 yo). Similarly, batch cooking and freezing prepared meals were common methods to enhance the longevity of foods. "I was buying like a tray of chicken breast... butterflying them, putting them in freezer bags... you can just pull them out when you need them" (M, 29 yo). In contrast, preparing meals required more flexibility due to the availability of ingredients. For example, when participants could not get specific items from the

supermarkets, they often reported substituting ingredients based on the groceries they had available at home.

Turning to shopping habits, many participants initially purchased extra groceries (i.e., long-life products) as a precautionary measure due to the risk of social isolation. In particular, participants with families were concerned about their children becoming hungry if there was not enough food available. However, worries lessened over time as stock availability improved and panic buying ceased. "We're starting to go through stocks now. . . it got to the point where the cupboards were overfilled. . . I've got so many children in the house and I couldn't risk being without" (F, 44 yo).

Considering food insecurity, finances did not affect our participant's perceived approach to eating. However, some reported shopping differently and were more mindful of expenses toward food.

"I would just say I've tried just be a little bit more careful with what I buy. . .I've looked at not always buying the non-essential, so I've cut back on alcohol, which isn't an essential, or I've bought cheaper brands of things" (F, 39 yo).

Theme 2: Dietary Instability

Despite improvements to nutrition from fresh cooking and reduced access to convenience foods, there was a common theme whereby perceived eating habits were negatively influenced during the pandemic. Primarily in the beginning of the lockdown, the overconsumption of calorically dense foods varied, lasting from a few weeks to even a few months. Dietary instability is explored through the sub-themes, (1) using food as a coping mechanism and (2), accessibility to calorically dense foods.

Sub-Theme: Using Food as a Coping Mechanism

Boredom eating affected many participants during the pandemic. Participants believed this habit was stimulated by prolonged periods spent at home, without any meaningful activities that usually prevented mindless eating. "whenever I'm bored, the first thing I think about doing is eating" (F, 27 yo). Consumption of energy dense foods was linked to activities such as watching TV. For example, one participant frequently perceived a loss of control over eating due to being distracted.

"I'd be watching something or on my phone and then it would be gone. I'd be like, what happened there? You don't even realise how much you've eaten or that you feel full. . . you're not even paying attention to the fact you're eating" (F, 29 yo).

Additionally, some considered the comforting effect of eating. This demonstrates that specific foods were perceived to effectively alleviate anxiety, stress and frustration experienced throughout the pandemic. For instance, buying treats was often reported to boost morale within families and keep children happy. "Just for comfort for us all really. . . to have nice things in the house. . . you know when the children, if they get upset, oh come on we'll have a little sop and we'll have a nice biscuit" (F, 51 yo). Relating to this, participant's overall calorie intake increased due to perceptions of eating more energy dense foods during the lockdown. Frequently mentioned foods were biscuits, chocolate and crisps. "Junk foods as well, bought a lot of pringles and biscuits and cookies, like noodles, pasta that you just put in a pot with the dried stuff, so not a great diet" (M, 21 yo).

Some participants believed their food choices had altered during the lockdown, because they developed a habit of consuming foods uncommon to their usual diet. "Crisps, and I'm not even a great lover of crisps. . . It's eating for the sake of eating" (F, 71 yo).

Sub-Theme: Accessibility to Calorically Dense Foods

Many identified overeating at home was related to the ease of accessing food, especially as participants reported buying more calorically dense food during the pandemic. Another believed resisting tempting foods was very difficult as their workplace provided free meals and treats during the pandemic. "Going into work we were having so much free food sent to us. Cakes sent to us, chocolates, brownies. We had so much stuff you wouldn't believe. . . I was eating cupcakes at half past seven in the morning" (F, 29 yo).

Alcohol intake increased for a few participants due to multiple reasons. For instance, without work responsibilities, furloughed participants felt there were more opportunities available for drinking during the week. One participant also believed drinking at home was an opportunity to socialize with friends, without the need to worry about driving.

"Quizzes or, you know, chats with friends online like, oh let's have a drink because I wouldn't normally if I went down the pub I'd drive. . . not like getting drunk every night but more, oh I'll have a glass of gin and tonic at home, which, you know, you would never hear me say pre lockdown." (F, 36 yo).

Theme 3: Eating for Nutrition

The following theme considers participants' perceived changes to eating habits which enabled them to revert to prior eating routines. After a period of indulgence during the lockdown, the novelty of frequently eating calorically dense foods diminished and participants were keen to eat nutritious foods to compensate. Two sub-themes explore this concept, (1) impact of diet on health and (2) management of calorically dense foods.

Sub-Theme: Impact of Diet on Health

Many participants revealed that they had gained weight during the lockdown due to reduced activity working from home and changes to diet and exercise, leading to discomfort and unhappiness with their perceived body image "I'm not as active, which means I'm not burning it off as much as I would have been. So, the weight has started coming on and I'm really uncomfortable. . . really feeling paranoid now so it's horrible" (F, 43 yo).

Also, many believed the overconsumption of energy dense foods impacted mood and wellbeing, often reporting feelings of guilt and regret for their food choices. Consequently, participants perceived that a change in mentality was necessary to modify their acquired habits and revert to a "normal" routine of eating, aiming to lose the weight gained during the pandemic. Eating nutritionally was underpinned by numerous factors, such as maintaining a good body image, health concerns (i.e., infection

risk from virus) and the physical improvements observed from their diet.

"If I stay healthier. . . God forbid something does happen. At least my body is going to be in a fit state to fight anything that I could pick up. . . I'm 54. You know, I'm a target age for it so, just give myself the best chance" (M, 54 yo).

Management of Calorically Dense Foods

Reducing the number of treats consumed, or not purchasing calorically dense foods were perceived strategies for improved nutrition. Participants believed this was necessary to reduce accessibility, as such foods could not be eaten if they were not readily available.

"I went absolutely mental and bought like twelve varieties of biscuits. . . I've never had a biscuit drawer in the fridge, and it was full to the brim. . . once it was gone and we ate it all I never topped it up. And I think that's helped not having it here" (F, 27 yo).

Adding to this, participants believed monitoring food intake enabled weight loss by providing focus on consumption. Various methods were used, including calorie monitoring through food tracking applications and the consumption of lower calorie treats, which satisfied cravings without overeating.

"We've changed simple things like crisps, instead of buying high in fat and high in calorie crisps. . . we've got Cheetos and Quavers and they're like 80 to 90 calories a pack. . . we're having light margarine instead of having real salted butter" (F, 21 yo).

Furthermore, intake was monitored in relation to the macronutrient content of food, as beliefs were held that avoiding some foods (e.g., high carbohydrate, high fat, fried) were necessary to eat nutritiously and lose weight. Of equal importance was the emphasis placed on consumption of lean protein sources to prevent hunger.

"If I'm having chicken it would be a good quality chicken breast and it would be a lean chicken breast. . . I will try to avoid high fat foods. . . I'll always look for the low-fat options on the labelling system" (M, 44 yo).

Besides monitoring intake, skipping meals and forms of dieting behaviours (i.e., intermittent fasting, meal replacement shakes) were believed to create a calorie deficit and decrease overall intake in some participants. For example, participants suggested that omitting lunch enabled consumption of a larger main meal or a calorically dense snack. This was stimulated by the realization of having additional calories available to allocate to other meals.

"We're having a good breakfast now. . . we're eating sort of eleven as our breakfast time. And then we're not having nothing through the day then. And then having a proper meal for tea" (M, 41 yo).

Theme: Perceptions of Panic Buying

Throughout the sample, panic buying was quite rare, only 17.5% of participants reported panic buying or stockpiling during the pandemic ($N = 7$). Participants revealed a variety of reasons for their behaviour. The sub-themes representative of panic buying perceptions are (1) reduce risk to health, (2) provide for families, and (3) social influences.

Sub-Theme: Reduce Risk to Health

Participants acknowledged that spending prolonged time in the supermarket increased their chances of contracting the virus. Therefore, they believed it was necessary to stockpile food as a precautionary measure, both to preserve their health and to be prepared if they were required to self-isolate. Furthermore, purchasing greater quantities of foods meant participants did not have to frequently attend the supermarkets. "I think the idea was buy so much food that we won't need to go shopping again anytime soon, so we weren't going out as regularly" (M, 21 yo).

Sub-Theme: Provide for Families

Many participants with children emphasised their responsibility as a parent to provide food for their families, so would stockpile to ensure there was enough to feed the family. Interestingly, some participants acknowledged their child's preferences for specific brands, so would purchase more when given the opportunity to ensure their child's needs were met. "we experienced a bit with [names son] waffles . . . our concern and this was maybe selfish but as long as he had enough waffles to get him through a couple of weeks he'd be okay" (M, 44 yo).

Sub-Themes: Social Influences

Additionally, general social influences were reported to be a driving factor of panic buying. Observing others buying excessively was a perceived trigger for panic buying. "I was a bit like oh gosh I've got hardly anything in mine, look at there's and then I was trying to work out are they just greedy or have they got a big family" (F, 27 yo). One participant suggested "people just kind of jump on the bandwagon" (F, 27 yo) and follow the actions of others due to the situation uncertainty. Our findings suggest social influences on stockpiling were mainly caused by observing people they did not know, as only one participant reported their decision to stockpile was influenced by a known person. "Before the lockdown I had a friend call up going quick go buy everything because they're going to close the shop, and I was like, are they? . . . you've got such a big responsibility. . . you can't just sit back" (F, 44 yo).

We note that whilst few of our participants reported engaging in panic buying themselves, many of them were aware of the behaviour more generally and readily expressed an opinion on the behaviour. Many believed panic buying was selfish because "it meant that other people had to go without" (F, 61 yo). Others speculated about the role of news stories and social media had on the prevalence of panic buying "there was probably one photo circulating on social media of an empty supermarket and it probably generated hundreds of people going well I need to go and bulk buy" (M, 41 yo). On the other hand, many tried not to impose judgement as they assessed the context as to why people might have been buying more.

DISCUSSION

The aim of this research was to explore how eating habits were influenced during the first lockdown of the pandemic with a particular focus on emotional eating and panic buying. Since

the coronavirus pandemic this is one of the few qualitative studies (Filimonau et al., 2021; Menon et al., 2022; Razi and Nasiri, 2022) that has aimed to understand how people without diagnosed eating disorders have managed food intake in novel circumstances. Our results provide an insight into the use of food as a coping mechanism during novel circumstances. Furthermore, the findings highlight how modifications to the immediate food environment can both facilitate and ameliorate emotional eating. Using thematic analysis, four broad themes and sub-themes were established. There was a consensus that being more organised and planning meals ahead was necessary to limit supermarket visits. Altered work schedules provided the luxury of time to focus more on cooking fresh meals. However, surplus time in combination with being at home created a high susceptibility to boredom eating, leading to a lowered mood and weight gain for some. Consequently, many participants tried to eat nutritiously after a period of overindulgence and utilized strategies to manage their consumption of energy dense foods at home. Perceptions of panic buying revealed that the media accentuated the lack of food available. Also, the decision to purchase extra food supplies was influenced by the behaviour of others and individual circumstances (i.e., people with big families, buying for vulnerable people).

A key theme highlighted the opportunity to cook more fresh food at home. The circumstances of the pandemic facilitated fresh cooking by removing imposing work schedules. Consequently, more time for cooking meant participant's perceived diet had improved by eating more fresh food. The current findings support previous research investigating the perceived barriers and facilitators to cooking (Lavelle et al., 2016). Time was also a perceived barrier as participants often relied on convenience foods due to work pressures, suggesting limited time for cooking. However, lockdown measures restricted access to takeaways and provided flexibility around meal preparation as participants were furloughed or working from home. Interestingly, despite continued access to ready meals in the supermarkets, many had reduced their ready meal consumption during the pandemic. The findings suggest the opportunities for cooking fresh food are heavily influenced by time management. In addition, Lavelle et al. (2016) reported intentions toward home cooking were facilitated by planning and organizing meals prior to food purchases. Our participants also reported eating nutritiously due to meal planning. In contrast, eating freshly cooked meals was not the main objective for organisation. Rather, considering the context of the pandemic, participants regarded planning as necessary to reduce shopping, as frequently attending supermarkets increased exposure risk to the virus. Furthermore, the prevalence of panic buying meant planning meals was often hindered by availability of ingredients in the supermarket. Consequently, participants adopted a flexible approach to cooking and adapted meals accordingly.

Despite a perceived improvement to diet, lockdown measures meant prolonged periods were spent at home and changes to work commitments meant surplus time was available. Perceptions were held by participants that these environmental changes led to the development of maladaptive eating behaviours. The occurrence of such behaviours can be interpreted through the theory of emotion regulation (Gross, 1998). The theory differentiates between two aspects of emotion regulation. Antecedent emotion regulation focuses on responding to the emotion before it has occurred to lessen its impact when the emotion takes place. For example, the uncertainty of the situation in combination with fears of contracting the virus may have led individuals to buy more food than typically needed to avoid needing to leave their home more than necessary (i.e., situation selection and modification). Also, more free time may have increased thoughts about deciding what meals to have and ensuring there was enough snacks for families (i.e., attentional deployment). Adding to this, the decision to purchase more energy dense foods might be influenced by the expectation that such foods will please family members and improve mood (i.e., cognitive change) due to the restrictions imposed. On the other hand, response focused emotion regulation which explains attempts to intensify, diminish, extend or suppress the emotion after it has been experienced. For instance, the removal of work or meaningful hobbies induced an enduring state of boredom, whereby the abundance of food in the immediate environment may have been used to suppress boredom. Studies have consistently shown that the use of suppression for regulating emotions often exacerbates emotional eating (Evers et al., 2010; Romano et al., 2021). Furthermore, a recent study by Buckland et al. (2021) found increased consumption of energy dense foods was positively associated to having higher scores on food responsiveness and emotional overeating and lower scores on emotional undereating. These findings were also evident in the current sample whereby overconsumption of energy dense foods was facilitated by the availability of foods and to regulate negative emotions. The study also found that acceptance significantly reduced the effect of having low control over cravings and consumption for energy dense snacks. However, the current sample demonstrated forms of active coping to manage energy dense food consumption by reducing purchases of energy dense foods and monitoring food intake. The current findings have implications for the management of emotional eating during lockdowns. For instance, education which focuses on how food influences mood and emotions may help individuals to make more balanced choices. Also, clinicians could devise both antecedent (i.e., having less energy dense food at home, attributing more positive values to the consumption of healthier foods) and response focused (i.e., going for a walk when feeling bored, call a friend or family member) to increase self-efficacy in individuals that they can effectively deal with negative emotions.

Of importance is the perceived engagement in disordered eating behaviours during the first lockdown. Although participants did not report having any prior eating disorders, many experienced heightened body dissatisfaction, binge eating caloric food and loss of control over eating. This is consistent with findings from the general population (i.e., no diagnosed eating disorder) in Australia, where rates of binge eating increased for 35% of participants (Phillipou et al., 2020). Moreover, the pandemic exacerbated effects for individuals with existing eating disorders. For instance, reports from the Netherlands (57%) and United States (58%) revealed concerns that spending extended time at home (i.e.,

a triggering environment) would aggravate eating disorders (Termorshuzien et al., 2020). There was much variability across participants concerning their perceived duration of maladaptive eating habits which ranged from weeks to months, although some did not experience any significant changes. In line with Konttinen (2020), the occurrence of overconsumption could be attributed to the continuous stress induced by the pandemic (i.e., concerns over personal safety and fears of contracting the virus), the abundance of energy dense foods in the immediate environment and genetic factors that could predispose eating behaviours. Adding to this, the initiation of dieting plans during the pandemic is also perceived to be potentially harmful. People who adopted such behaviours were almost 10 times more likely to have eating disorder symptoms than those who didn't make any dietary changes during the pandemic (Chan and Chiu, 2021). Comparably, participants in the current study also employed various strategies to manage consumption of caloric foods. Unique to the pandemic, reduced access to convenience foods and restaurants meant shifting focus to aspects of the home environment and shopping habits. For instance, purposely not buying caloric foods was also reported by Gatzemeier et al. (2019) to reduce accessibility and manage consumption. Strategy uses could be explained by implementation intentions (Gollwitzer, 1999). This concept is a self-regulatory process which facilitates goal attainment (i.e., trying to eat nutritiously) by identifying maladaptive eating habits (i.e., boredom) and planning an alternative behavioural response that is congruent with nutrition goals. Current findings suggest many participants implemented their desired eating intentions by replacing energy dense snacks with lower calorie alternatives (e.g., fruit, yoghurts). Therefore, participants perceived their diet to be more balanced, as they did not completely deprive themselves of treats. The adoption of such strategies could protect against disordered eating by adopting dietary practices which are deemed manageable by the individual and do not exclude particular foods (King et al., 2020).

These findings highlight the complex interconnection between weight management and disordered eating habits, whereby the use of appropriate coping strategies is critical to ensure that initial eating problems do not surpass clinical thresholds. Additionally, extended waiting times have implications for service users, whereby increased distress through could result in a longer recovery time (Austin et al., 2020). Likewise, the inundation of eating disorder services could lead to increased pressure on clinicians to address backlash caused by the pandemic. Consequently, there is need for more funding for roles that can support clinicians, as the replacement of traditional face-to-face treatments with online methods has received mixed responses with regards to satisfaction and engagement with treatment (Stewart et al., 2021). Furthermore, Hamilton et al. (2020) highlighted weaknesses of the modern food system (e.g., overreliance on technology, homogenous crops) whereby future supply shocks are likely to occur, consequent of another pandemic or the emerging climate emergency. Mitigating the effects of a food system shock is essential to protect vulnerable individuals from using maladaptive forms of eating to cope with negative emotions.

Turning to food purchases, participant's behaviour was consistent with research regarding the psychological causes of panic buying. Yuen et al. (2020) indicated the perceived threat of the situation was the most predominant cause of panic buying. In relation to the pandemic, some participants were motivated to bulk buy to prevent leaving home, as supermarkets were perceived as a high-risk environment. Also, Yuen et al. (2020) acknowledged the importance of social factors on panic buying (i.e., normative influences, observational learning) but did not consider the individual context that predisposes panic buying. For instance, many of our participants reported buying extra, indicating a responsibility to provide food for families. Although most of our sample did not report engaging in panic buying, this is consistent with Bentall et al. (2021) where over-purchasing was also minimal in British adults. The study also reported that panic buying was predicted by having a higher household income, presence of children at home, psychological distress, and increased threat sensitivity. However, the current findings contradict a recent review by Rajkumar and Arafat (2021) which indicated that higher income was a larger risk factor for panic buying. However, it seemed that as the current sample did not experience significant difficulties with obtaining food, there was no justification to purchase more than necessary.

Relating to this, one issue with food that was notably absent from the current sample was food insecurity. This could be attributed to the lack of cultural diversity amongst the current sample, as there was no representation amongst Black, African, Caribbean, or Asian populations. A recent study found that the odds of being food insecure were two times higher in ethnicities which were Mixed or White other, in comparison to White British (Yau et al., 2020). Such disparities in the experience of food insecurity across ethnic groups are also apparent in other cultures (Rezazadeh et al., 2016; Mishra and Rampal, 2020; Bukari et al., 2021; Tefera et al., 2022). Food insecurity influences a plethora of issues relating diet quality (Velde et al., 2020), eating disorder pathology (Hazzard et al., 2020), mental illness (Elgar et al., 2021), and obesity (Wu et al., 2019). Relating to the current study, it could be suggested that choice of coping mechanisms is also applicable to people with food insecurity. For instance, a study by Keenan et al. (2020) found that household food insecurity was indirectly associated to having a higher body weight through experience of distress and eating to cope. However, its notable that coping mechanisms are likely to vary depending on the severity of food insecurity and culture. For instance, food insecure individuals from Western Africa reported that cooking and sharing meals with other families was able to improve mental health (Myers et al., 2019). Likewise, Aboriginal and Torres Strait Islanders relied on extended family members for support, but the use of social comparison (e.g., others are in a worse situation) helped families to remain positive (McCarthy et al., 2018). Finally, findings from a review conducted in Malaysia reported various forms of emotional coping such as aspirations (i.e., faith that good fortune will triumph), resignation, distraction, and frustration (Sulaiman et al., 2021). Altogether, these findings highlight the importance of cultural values when considering the role of coping with distress in relation to food insecurity, overconsumption and panic buying behaviours.

The limitations of this research are attributed primarily to the sample demographics. As previously mentioned, all participants were employed or received furlough money throughout the pandemic. As participants' ability to eat and obtain food was not significantly affected by finances, we were unable to explore food insecurity. This suggests the current findings are not generalizable to individuals who were financially constrained during the pandemic. Furthermore, the study recruited a convenience sample where the ethnicity of participants was White. Therefore, this study does not account for differences that may be apparent for people from diverse cultures. Finally, findings were based on participants with a large age range. Therefore, we cannot assume participants of all ages were equally susceptible to their perceived eating habits, and whether reported strategies were similarly effective for reducing the consumption of energy dense food.

The current findings highlight a number of opportunities for future research; firstly, there is a need to understand the long-term consequences of altered eating behaviours consequent of the pandemic, for people without a previous eating disorder. Despite participants' perceived management of energy dense foods, its unknown whether the reported management strategies are successful when challenged with previously formed habits (i.e., eating whilst watching TV), especially in circumstances of prolonged isolation and reduced access to social support (Rodgers et al., 2020). In addition, conducting this research in food insecure populations can explore the differential challenges encountered when accessing food and the implications this has for malnutrition in families and their subsequent risks for developing an eating disorder. Finally, stockpiling throughout the pandemic disrupted the food system, as a consequence of the critical discrepancies between consumer demands and the retailer's ability to provide supplies (Panzone et al., 2021). Considering the economic impact of stockpiling is necessary to assess the resilience of the food supply chain. However, future research should integrate an economic and a psychological understanding to better predict consumer behaviour and prevent future problems with panic buying.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Swansea University Research Ethics Committee. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

TR and LW developed the initial idea. TR planned the study, carried out interviews, analysed the data, and wrote the original draft of the manuscript. LW supervised the research. CM assisted with researcher triangulation of the thematic analysis. All authors reviewed and edited the manuscript.

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COVID-19 and the National Lockdown: How Food Choice and Dietary Habits Changed for Families in the United Kingdom

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COVID-19 changed the way families in the UK live, with as yet uncertain impacts to food choice and dietary habits. This study sought to explore food-related experiences and changes to behavior of families with children, during the pandemic. Semi-structured one-to-one interviews with parents ($n = 20$) and, separately, their children ($n = 22$; aged 8–10 years) were conducted. An inductive thematic approach was adopted for the data analysis, and four main themes emerged: commensality; elevated place of food in the home; snacking; and food shopping. Study findings highlighted several changes: some related to increased snacking and more takeaway food; others were more favorable, including spending more time together, increased home cooking, more efficient shopping practices and reduced food waste. Overall, an elevation of the place of food within the home was apparent, alongside enhanced food literacy, and some evidence of the relocalisation of food. This study contributes to the international literature on the impact of COVID-19 and national lockdowns on family lifestyle behaviors, specifically food choice and dietary habits; further research into the longer-term effects of COVID-19 on family food practices is required.

Keywords: COVID-19, food choice, family food, food environment, food literacy, dietary habits, children, food practices

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INTRODUCTION

The World Health Organization characterized COVID-19 as a pandemic on 12 March 2020 (1). Following this, many countries implemented measures (such as enforced restrictions on movements and activities) to control the virus's transmission. The UK government announced the first national lockdown period on 23 March 2020; the population was asked to stay at home-with the exception of essential travel, medical or care needs, and daily exercise (2). People were asked, where possible, to work from home and follow social distancing guidelines (2). In the same announcement, people were asked to do food shopping as infrequently as possible, and to use food delivery services where possible (2). All schools were mandated to close (with the exception for the most vulnerable children and children of keyworkers) (3) and schools moved to remote learning. As a result, many children spent their days alongside their parents, and many families became confined to home for much of the time.

The UK government announced that a phased reopening of schools could begin in June (4). However, the cap on class sizes meant that a return to schooling was not possible for all (5), and many children did not return until the new academic year in September 2020 (6). Following a relaxation of restrictions over the summer, COVID-19 case numbers began to rise and the UK was in a second wave, when a second 4-week national lockdown was instigated in early November (schools remained open during this second lockdown). Case numbers continued to rise over the Christmas period however, and the UK government implemented a third national lockdown on 4 January 2021 (7), which again included the closure of schools.

The lockdown measures are likely to have had considerable impact on the nation's day-to-day lives. Similar enforced restrictions in other countries have resulted in changes including those associated with unhealthy lifestyle behaviors in families. A cross-sectional survey of 254 families in Canada reported that families with young children experienced increased snacking, decreased physical activity and increased screen time in both parents and children (8). Interestingly, favorable changes were also observed, such as eating less fast food, spending more time cooking and preparing more meals from scratch, as well as eating together with children more often and involving children in meal preparation (8). Likewise, another survey of 498 parents of children (aged 3–12 years) in France found an increase in children overeating and snacking more frequently during lockdown, as well as more home cooked meals and cooking more with children (9). Favorable changes were also reported in Greece, in a survey of 397 children and their parents; these included increased home cooking, reduced fast food, and increased fruit and vegetable consumption (10). However, increased body weight was found in 35% of respondents and this was associated with increased snacking, as well as decreased physical activity (10). Another study, from Italy and involving 41 children (aged 6–18 years) with obesity, found unfavorable lifestyle changes during lockdown, such as increased sugary drink intake and decreased physical activity (11).

Internationally, much of the research into the impact of COVID-19 on dietary habits has been through cross-sectional questionnaires. Few qualitative studies have explored families' experiences; one Californian study involving 48 parents of children (5 to 18 years) found changes in eating habits, increased snacking and more family connectedness at mealtimes (12). Another qualitative study with 25 primary food gatekeepers in Australia reported increased home cooking, enhanced food literacy and increased consumption of family meals (13). Further, there have been studies examining food intake in children with obesity (11), and surveys to examine children's eating habits (14). However research exploring children's experiences during lockdown, including children's food-related experiences, is lacking.

During the first national lockdown in the UK, children were at home with their family for a sustained period; the changes to their diet and food habits is not known. For example, the effects of changes to shopping, as well as spending more time within the home food environment, and with family members, is unclear. It is also important to note that children ordinarily spend a large proportion of the year in school, and school meals can make an important contribution to children's diets. Weight gain in children has been associated with school holiday periods (15, 16)–and indeed, a sharp increase in the prevalence of obesity is conspicuous in the National Child Measurement Programme in England for 2020/21, for 4–5 and 10–11 year olds (9.9% in 2019/20 to 14.4% in 2020/21 and 21.0% in 2019/20 to 25.5% in 2020/21, respectively) (17).

Food choice is multifaceted, complex, and dynamic. Given the multiple changes accompanying the national lockdown, changes to family food habits and food choice may be anticipated. Socioecological theory suggests that health-related behaviors such as food choice are influenced by factors both intrinsic and extrinsic to the individual (18). Levels of influence include: the individual, their attitudes, preferences and beliefs; interpersonal relationships with those closest to them such as families, friends and social networks; the community in which they live; and the wider society and public policy (19). Stressors related to COVID-19 such as prolonged lockdown, fear of infection, financial loss, lack of in-person contact with others, frustration and boredom have been reported (20–22); it is not known how these may have influenced families' food choice and dietary behavior during the COVID-19 pandemic. Likewise, the changes to food access due to government restrictions (for example less frequent food shopping and more food delivery) could influence family food choices during this time.

An important consideration in this is the home food environment, which is a series of interactive overlapping domains, relevant to dietary behavior (23). Influenced by social, cultural, political and economic factors, the domains have multiple contributions–including those most central to a child such as food availability, parental diet, practices and rules, and family eating patterns (24). Parents are crucial moderators of food within the home and, as nutritional gatekeepers (the person responsible for planning, sourcing and preparing family food), parents can contribute to creating environments that foster healthy eating behaviors or promote unhealthy choices and excess weight (25). Children have generally reported a lack of input when it comes to food purchasing decisions and that instead, their parents' financial and health concerns informed food shopping and ultimately choice (26). Other research however, has pointed to primary school-aged children as active decision-makers regarding food choice (27), and as agents of change influencing cooking and food choice at home (28) with growing authority over everyday food decisions (29).

We need to understand how COVID-19 and the restrictions of lockdown impacted families' food practices and food choice–in order to consider the implications and inform support for families post COVID-19. This study aimed to explore the food-related experiences and perspectives of families with primary school-aged children during the COVID-19 pandemic and the national lockdown.

MATERIALS AND METHODS

Study Design

A qualitative methodology was chosen based on the study's emphasis on families' individual experiences, their household activities and how and why they behave in specific ways. This can enable a focus on participants' everyday life experience (30), and provide theoretically generalisable data to develop concepts and understand phenomena (31).

One-to-one interviews were chosen as they provide more detailed insight into participant experiences and a better understanding of their behavior, than focus groups (32). Semi-structured interviews were selected to allow for discussion and to pursue interesting and emerging themes in depth. Separate interviews for each parent and child of each dyad (pair of related individuals) was chosen to enable greater insight into family life during the pandemic, and to support participants talking more freely and with less influence. In particular, it has been suggested that a parent's presence in a child's interview may prevent them from being heard (33). Online interviews were planned, as it made sense during the time of social distancing, particularly as video communication to keep in touch with family and friends, for schooling, and for work had become more commonplace during the pandemic (34). Further, a researcher's remote presence and lack of obtrusive recording equipment can promote informality and a sense of ease, conducive to researcher-participant rapport (35).

An inductive approach for the data analysis was chosen to allow findings to emerge from the data's frequent or dominant themes (36). Reflexivity was embedded within the study design, to recognize the role of researchers in the process and to try to reduce the influence of preconceived opinions (31). Specifically, memoing and researcher discussions took place throughout the study design, data collection and analysis, and sources of bias were acknowledged and reflected upon. Ethical approval for this study was granted through the faculty research ethics committee.

Recruitment and Participant Eligibility

Parent-child pairs were recruited through purposive sampling; parents were required to have spent the first lockdown at home, either working or not, with at least one child (Year 4 or 5; aged 8–10 years) who was not at school between 23 March and 8 September 2020. This age group was chosen as these children were not included in the phased reopening of schools in June 2020 (37) and therefore experienced longer periods of school closure. Parent-child dyads were recruited through a junior school in a market town in the north of England. The school had a larger than average cohort in target years 4 and 5 (8–10 years), and whilst the school was located within the 40% most deprived neighborhoods in England (38), <10% of pupils were eligible for free school meals, lower than the national average of 17.3% (39). Initial contact with the school was made by email and followed up with discussions with the school leadership team. Following school agreement to participate, all parents of year 4 and 5 pupils were invited to participate via a notification on the school's parent communication app. The notification provided outline details of the study and the researchers' contact details. Parents who expressed an interest were provided with further details and the information sheet for the study.

Interview Schedules

Two interview schedules were developed: one for parents and one for children. The questions and associated prompts focused on families' experiences around food during COVID-19 and the first national lockdown period. Both the parent and child schedules explored food practices and dietary behaviors; questions related to topics, such as food choice, food shopping and preparation, food practices in the home, and food from outside the home. The questions were developed to be open, and non-leading, with particular attention paid to age-appropriate wording for the child interview schedule, e.g., Can you tell me what you remember about the first national lockdown when your school closed? What about food during lockdown, what do you remember about that? A final question gave participants the opportunity to introduce any information they thought was relevant but which had not come up. The interview schedules were reviewed by an expert panel of academics and public health practitioners who provided feedback on content, appropriateness of topics and the language use. Six pilot interviews were conducted with three parent-child pairs, and the interview schedule was refined to allow for more relevant discussion and to improve the question order. The interview schedules are available from the corresponding author upon request.

Data Collection

Semi-structured interviews were conducted in November and December 2020 (during the second UK national lockdown). In total, 40 interviews were conducted, each with one parent or child from parent-child dyads, except for two interviews involving two siblings in the same household fitting the eligibility criteria. Interviews with parents and children lasted on average of 26 and 15 mins, respectively. Informed consent was gained and interviews were conducted remotely using video conferencing software (Microsoft Teams), with participants in their home. A researcher led the interviews using the interview schedule; however, this was flexible and depended upon the direction of discussions and topics arising. During each interview, the researcher noted non-verbal observations, salient points, and initial thoughts for inclusion in data analysis. Immediately following the interview, parents completed a short online questionnaire to collect demographic characteristics. Recruitment and interview of dyads was conducted until it was felt that data saturation had been reached, and there were no further issues or insights arising from the data.

Data Analysis

Interviews were video recorded with the participants' consent, and then transcribed to a protocol using a denaturalised approach removing interview noise such as stutters and mannerisms (40). Transcripts were checked twice against the video recordings for accuracy, and then anonymised. The transcripts, researcher memos and observation notes provided the data for this study, and were imported into the software package, NVivo 12 Plus (NVivo 12 Plus, QSR International, Melbourne, Australia) to

help with data management and data analysis. An inductive approach was adopted for the data analysis, which entailed data exploration, inductive coding and thematic analysis (36).

Coding was conducted to capture participants' attitudes, perceptions, and experiences related to food. This was an iterative process, and once all data had been initially coded, researchers reviewed and discussed the coding, before beginning another iteration. In all, four iterations of coding took place, with coding reviewed and refined with each successive iteration. Themes were identified from main concepts that appeared across multiple interviews and significantly contributed to understanding the research topic.

RESULTS

A total of 20 parents (19 mothers, one father) and 22 children participated in the study. Parents were aged 26–50 years, with the majority over 36 years. Children were aged 8–10 years, with most aged 8 years. All but one parent and child pair were white British, and all households were two-parent families, with most having two children. Participants lived in areas with an IMD decile 4–10 (10 being the least deprived), with 70% of participants living in areas with an IMD decile six or above, indicating lower deprivation levels (38), and four fifths of households had annual household incomes of £50,000 plus (80%). Demographic information for participants is provided in **Table 1**.

Data analysis provided four themes: commensality, elevated place of food in the home, snacking, and food shopping. Themes and associated sub-themes are presented in **Table 2** and described below, with quotations to illustrate findings. Unique identifiers are assigned to participants, e.g., P1 and C1 are the parent and child participants, respectively, of one dyad (in the two instances where two children of the same parent were interviewed these are denoted, e.g., C6a, C6b and P6).

Commensality

Many participants reported changes relating to commensality [a concept to describe eating with others (41)] during lockdown. Some recognized feeling positive about eating together as a family more, whilst others missed social interactions (which often involved food) with wider family and friends.

Enjoying Eating Together More

Children and parents alike recognized that they were spending more time eating together and enjoyed this. Sitting to eat together more regularly became important, and many reported mealtimes at home as a more social occasion.

> *... in lockdown: breakfast, lunch and tea, it was all [of us eating] together–we made a point that no electronics [were out]... we're going to just sit and have this time... we might not ever get the time like this again, really (P13).*

> *I think we probably ate more together as a family because obviously we weren't... we're normally all here, there, and everywhere, and I think it probably meant that we actually spent more time eating as a family (P16).*

> *It [eating together] felt a bit more happy, happier than usual because we get to, we got to talk about, we got to talk about things and our worries (C1).*

> *It was nice to be with my dad... It was different because [usually] he works on weekends, and we're off. He doesn't work on a week, and we're at school. We don't really get to see him that much. I'm really glad that we get to see him more than we used to do before lockdown (C14).*

Changes to mealtimes, often with parents eating their evening meal earlier than pre-lockdown, enabled families to eat together and was possible because after-school activities and work were no longer barriers. For children, large lunches (in school) and small convenient evening meals were replaced by smaller snack-type lunches and large, social evening meals. Interestingly, participants reported continuing post-lockdown to try to eat together as often as possible.

> *Normally we would eat separate to the kids, just through work patterns and time I get home and stuff, but we were sitting down as a family and eating more together (P17).*

> *I think food has remained a social thing, in that it's what the four of us do, to have a focus point of the day and to sit down together (P11).*

Missing Socializing With Food

As well as eating together as a family more, parents acknowledged missing eating with others, particularly extended family and friends.

> *That [food] completely changed because on weekends [before lockdown], we were basically spending most of our time with friends. We were always eating out or eating at someone's house or someone was coming over to ours (P13).*

> *I missed the family, eating with the family. That was the biggest thing for me (P15).*

In parallel, children enjoyed more family meals but missed their friends and missed eating with friends during the "noisy" social school lunch.

> *It was quite weird: normally, I'm crowded with people around me... while I eat (C18).*

> *I missed having a really good chat. I always miss... seeing my friends, just seeing everyone eating and hearing the chatter of other people around me (C16).*

> *I was sad that I didn't get to see my friends because of lockdown. That made me sad, that I didn't get to see my friends. Also... I miss talking to them in the dinner hall (C14).*

Interestingly, children also referred to returning to school post-lockdown, and having to eat lunch in the classroom rather than the dining hall and still not being "*allowed to move to where your friends are sitting*".

TABLE 1 | Demographic characteristics of parent and child participants.

Parents		
	n	**%**
Sex		
Female	19	95
Male	1	5
Age		
26–30 years	2	10
31–35 years	1	5
36–40 years	5	25
41–45 years	9	45
46–50 years	3	15
Education		
A-Level or equivalent	5	25
Degree or equivalent	15	75
Ethnicity		
White-English/Welsh/Scottish/N Irish British	19	95
Mixed/Multiple ethnic background	1	5
Employment status prior to lockdown		
Homemaker	2	10
Self-employed	1	5
Student	1	5
Working full-time	9	45
Working part-time	7	35
Employment status during lockdown		
Furloughed	1	5
Homemaker	3	15
Student	1	5
Working from home	15	75

Household		
	n	**%**
Household income		
£15,000–£29,999	1	5
£30,000–£49,999	3	15
£50,000–£74,999	6	30
£75,000–£99,999	9	45
£100,000+	1	5
Household composition		
2 adults, 1 child	3	15
2 adults, 2 children	11	55
2 adults, 3 children	4	20
2 adults, 4 children	1	5
3+ adults, 2 children	1	5

Children		
	n	**%**
Girls	11	50
Boys	11	50
8 years	14	64
9 years	4	18
10 years	4	18

Elevated Place of Food in the Home

During the interviews, parents referred to spending more time on food-related activities, e.g., meal planning, shopping, preparing, cooking, as well as making food more "special" and using food as a source of enjoyment. Some parents recognized that they were becoming fatigued with the situation–and looked to "nicer food" and takeaways to try to alleviate the food monotony. Children also had more involvement in food preparation and expressed their opinions over food choice more often. Overall, it was apparent that food had acquired an elevated place within the home.

Children More Involved With Food

Children were more involved in cooking and baking; parents explained this as an activity to do while children were spending more time at home.

> *I think a lot of the activities we did, looking back, revolved around food, even making it, or playing with it, or preparing it (P15).*

> *We did lots and lots of cooking. We cooked cakes and baked cakes... We'd make a lot of cakes, and we made… I remember we made loads of cheesecakes (C12).*

I think I did a bit more [cooking] because I didn't really have much time when it was not in lockdown, to bake because I only really had weekends off and so there's not really much time after school. So I think I did a bit more (C16).

Parents also spoke of children being more involved and wanting "to have a bit more of an input" in what they were eating, and playing a more central role in food decisions, with more freedom to choose. Children also reported this increased input into their food choice.

*I mean she [daughter] got a bit more picky about what she wanted. It was always **this** cereal bar, then she was like, "Oh, I want a fresh fruit salad" and, "I want this" and, "I want that", and she was more specific about what she wanted (P3).*

It went from having some Weetabix before he [son] went to school to, "Well, I'll just have some boiled eggs on toast", and "I'll just have some chopped up fruit while I'm waiting", and "I'll just have this, and I'll just have that" (P4).

He [son] had a lot more freedom with it [food] as well, because he'll just go and get something from the fridge (P8).

Some days they'll [children] come up to me before I even start cooking and they were like, "Can we have this tonight?" or they knew if I was going shopping, they'd ask for a specific thing (P3).

A popular meal for children during lockdown was a "snacky lunch", a variety of (typically) cold foods such as boiled egg, sliced meats, sliced/cream cheese and vegetables slices (e.g., peppers, carrots). For some children, snacky lunches were introduced during lockdown; for others already familiar with snacky lunches, these were eaten more often.

At lunchtime, her [daughter] and Evelyn [other daughter] developed a meal called "Scraps and Pieces", which sounds ridiculous, but basically, it was things like carrots, cucumber, houmous, celery, ham, all on a plate with different vegetables. That was their favorite thing and that's what they ate pretty much all of lockdown (P16).

For lunch, we would probably have... a snacky lunch, where we would have, maybe a bit of ham, a bit of cheese, a bit of cucumber, a bit of tomato, and maybe a boiled egg (C19).

Interestingly, once lockdown ended and schools reopened, it emerged that more children took packed lunches than before. Children felt that packed lunches gave them more input into their food, or felt that it was easier than consuming school lunches in the classroom (which was the practice when they returned to school post-lockdown).

I can choose what I put in [my packed lunch], instead of having the same thing (C2).

She [daughter] wants to be independent... that's why she wants to take her lunch with her (P15).

TABLE 2 | COVID-19 and family food during the national lockdown: the four emergent themes and associated sub-themes, pointing to enhanced food literacy.

Enhanced food literacy ↑	
Commensality	Enjoying eating together more Missing socializing with food
Elevated place of food in the home	Children more involved with food Food as a highlight New recipes and new foods Making food more special
Food shopping	More efficient food shopping Food shopping as an event
Snacking	Snacking more Parents' strategies to control snacking

Since she's been back she's opted for packed lunches only now, because she hates having to go carry the tray back [to the classroom], because she's afraid she'll drop it (P10).

Food as a Highlight

It became evident that food became a primary source of enjoyment for many participants, who acknowledged it was one thing they could still influence and choose to enjoy.

It [lockdown] was just so boring and so mundane that we needed something to look forward to. You look forward to food because... we enjoy it; our family, we enjoy food. It was something to be excited about… like, look forward to, during the day (P13).

It was one of the main purposes of the day sometimes, which sounds ridiculous, doesn't it? But it was that one thing of... we'll get to sit down together tonight and eat a really nice meal (P11).

New Recipes and New Foods

Parents reported enjoying spending more time cooking and preparing family meals from scratch, explaining that they did not have time to do this pre-lockdown. Interestingly, parents felt that their children tried more new food, and that generally, there was more variety in what was eaten by the family, with different recipes and new foods.

I think the main thing for me has been just having that time now to be able to prepare food, nice meals for them, rather than always thinking, "Oh, God, they're eating crap all week!" (P17).

I was cooking more like my mum used to cook, or my grandma used to cook (P13).

I think I put a lot more thought into trying new foods and different recipes that we hadn't done yet (P9).

Overall, parents and children felt that the family was eating healthier meals, with less eating out, fewer convenience foods as well as more cooking from scratch. Many parents acknowledged

feeling good about this, satisfied to be providing "better" family food.

We cooked more healthy things. In our curries, we normally have loads of meat–but during lockdown, we had lots of vegetables (C13b).

We couldn't go out to restaurants, so we had to eat inside, and I think we ate healthier snacks (C19).

I made sure that we had plenty of fruit in and that the meals were healthy and they were cooked from scratch rather than convenience food and things like that (P11).

I have got that bit more time to meal plan, and make sure they're getting a probably more balanced range of meals... than they were before (P17).

Some participants also reported that some of these changes had persisted post-lockdown, and for example, felt like they were still eating healthier meals compared to pre-lockdown.

We still do meal plan, and we do still try to have a healthy tea as such, with vegetables. We're still making things pretty much from scratch, when it comes to certain meals (P7).

In lockdown we did try and make foods that we really enjoy. We've been trying to get those recipes back and trying them again (C13b).

Making Food More Special

Food became a focal point in the home, and parents reported spending more money on food and buying nicer food and treats. This was explained by not being able to eat out, having nothing else to do or to spend money on during lockdown.

The one enjoyment was: let's plan a really nice meal, that's healthy, that's really tasty but guilt-free and we can all sit down and enjoy that meal (P11).

Just trying to think of different recipes to cook and things that were, maybe a little bit more special and to make you feel like you had... a change of the routine (P20).

Parents acknowledged that, over time, food in the home became monotonous; and they were "*fed up of thinking and having to organize something every mealtime*"–opting for more takeaways, premium foods and eating outside to make mealtimes more interesting. Children recognized these changes too.

I think the longer that [lockdown] went on, it became a bit... frustrating, because we were just constantly having to cook and that probably also impacted on our creativity because we just got bored with it (P19).

We stopped really eating out because everywhere was shut, but we had takeaways and brought them home, so that was good (C16).

I mean, we had a lot of fast food in lockdown, we didn't have a lot before (C4).

The girls quite liked having a picnic outside on the grass; even though it's just in the back garden, it felt like it was a bit special (P16).

We let the kids eat outside a lot more. I think that was just a combination of trying to get them outside and a bit of fresh air–also, just a different location to eat (P19).

In the summer we ate quite a lot of meals outside on an evening. We spent a lot of time in the garden (C11).

According to parents, premium foods and takeaways also endured post-lockdown, displacing eating out to some extent.

We still don't eat out, still can't get my head round eating out very often. I don't like it, although we've done it a couple of times. We do now get takeaway. We probably now have takeaway once or twice a week (P18).

It's [takeaway] like us treat for the week, and it's something to look forward to. Frankie [son] absolutely loves it, so I've just carried on, and it's easier as well; I don't have to start cooking then [...] We're still getting us takeaways really. It's as if it's like your bit of enjoyment of the week as well (P8).

Snacking

Parents felt that they and their children snacked more. Increased snacking was also recognized by children in this study, and parents looked to implement strategies to control the number of snacks eaten by children.

Snacking More

Parents felt that children ate more snacks and talked about their children being hungry and asking for more food. The emphasis was on the requests for more food, rather than specific types of food, although common foods mentioned by parents included crisps, biscuits and fruit. Parents also commented that this was not "real" hunger, but instead, driven by boredom and availability of food in the home.

Yes, they had a lot of snacks [in lockdown]... I think they were hungry all the time. I don't think they actually were hungry; I think they were just bored (P16).

The thing with him [son] was that he was constantly saying that he was hungry. I think that's by being at home and knowing that there's a cupboard there that's full of food, that he can just nip in and get something (P6).

Children also recognized that they were "*snacking a bit more*" during lockdown.

Maybe, [snacked more] just because we didn't have to sit and just do our work, because if we were at school… and we had more freedom to go to the toilet more often and... to waste school time [laughs]. Olivia [sister] definitely snacked a lot more (C11).

Well, I would have more time to have them [snacks] because I wouldn't be at school or at gymnastics. Also, [pre-lockdown] I would be at school a lot, so I wouldn't have time to eat lots of things... except dinner at school (C14).

During the discussions, it was evident that most "snacks" were foods that were high in fat, sugar and salt, although some parents and children also reporting eating more fruit as a snack.

I've never bought so much stuff for them [children] to snack on. I've had a chocolate sweet tub which I've never had before (P7).

We ate a lot more fruits. Sometimes, we'd have a little snack in the sweet cupboard; apart from that, it was mainly fruits (C13).

Boredom was reported as a driver for increased snacking amongst parents, alongside wanting to treat themselves. For some, this was explained as a coping strategy for the ongoing stress and worry caused by the pandemic. For some parents, alcohol consumption increased for the same reasons.

Probably a little bit panicked about everything, so I'd probably just ate out of... emotion. I don't know, it were just a strange time (P14).

I think that [stress and anxiety] had a part to play, and I think as well, it was boredom. Knowing that we were having some treats that night or sharing a bottle of wine and some dips and crisps was like the highlight of the day (P15).

Parents' Strategies to Control Snacking

Parents acknowledged implementing strategies in response to their children's increased snacking. These included straightforward steps such as hiding the snacks away and offering healthier alternatives, as well as other ideas they had found online, such as putting out snack boxes or devising "price lists" to limit the amount eaten. Snacks were also used in some instances by parents, to incentivise children to complete tasks during the day.

I became a lot more aware of the amount of snacks the kids were having. I looked for tips, from other parents as to how they were doing it [limiting snacks] (P15).

I made a shop menu board, so they had to–each snack had a value, a price value–they had a pound a day to spend on snacks. Once that pound went, then they had no more snacks (P7).

Once Mummy made a massive price list and we had to pay for our sweets (C7).

Sometimes I did use it [snacks] as an incentive as well. If he [son] asked for some food, I would say, "Well, just do this piece of writing, and then you can have a snack" (P20).

Parents acknowledged that concern over their child's reduced physical activity and potential weight gain during lockdown, partly drove their desire to try to control their increased food intake.

So I'm never concerned about what she [daughter] eats because she does lots of sports, in and out of school. But during lockdown again she seems to have quite healthy appetite and I did sort of think, "Oh, how will this work, with her not exercising as much?" (P1).

Food Shopping

As well as altered food habits at home, shopping habits and routines also changed, with families introducing new and more efficient shopping. Participants' attitudes toward food shopping adjusted, in part, because of the changes to the retail food environment.

More Efficient Food Shopping

Parents spoke about the importance of planning meals and avoiding having to shop too often, and no longer 'nipping' to the shops. Families stopped shopping together for food and it became the exclusive responsibility of one member of the household, with children no longer accompanying them. Many of these changes were due to the restrictions in place, as well as fear and minimizing risk.

Typically, we'd sometimes go to the shop to pick up different bits and pieces during the week, but we stopped doing that (P19).

I was really conscious: we really must try and get everything in this one shop, to reduce, really, the risk of going out and being with anybody else. I really try to get everything on that Tuesday morning shop (P5).

Mum usually got really big shops, so it lasts quite a few weeks. It makes sure that we also have enough to last a couple of weeks, so we don't have to do a big shop the next day (C14).

My mum might have been scared that if I went inside, I might catch Corona because of all the people (C19).

Participants also adapted their shopping; many tried food deliveries for the first time and those who struggled to get delivery slots at supermarkets looked to local shops that had introduced deliveries during lockdown. Participants also shopped locally because they wanted to support their local economy, it was easier, and they had more time.

I think there was a couple of key things that changed after lockdown. I think one of the things was that we started ordering most of our food online. We stopped going to the shops just because of the risk factor (P19).

It did [shopping changed] a lot because we started getting just a click and collect once every week, and normally, before it was like, we'd go into the shop and... go around more and... things like that (C11).

One thing, actually, that we did do because we've had the time to do it, was to go to the local veg shops. I was buying more fresh fruit and veg (P6).

. . . the queues to get in [the supermarkets] were huge, and the whole rigmarole, the one-way systems, queuing at the checkouts, and things like that; it was just easier to go local (P17).

Interestingly, participants reported a reduction in food waste, explained primarily through increased food planning, and because using up all of the food within the home became more important as participants tried to avoid shopping.

I'd started having to get a bit creative of what we had left, like, "Oh, what can I put with this old spinach and this half of butternut squash?" or whatever (P5).

By Friday, there's not a lot in except what we're going to be making maybe on the Saturday, and then we go shopping again. I think that our food waste has gone down quite a bit (P13).

Post lockdown, many participants reported resuming their usual shopping practices, e.g., nipping to the shops more, no longer shopping online–however, some continued shopping more locally as they felt the food quality was better, it was more reliable, or they wanted to continue to support local businesses.

Food Shopping as an Event

During the interviews, it emerged that shopping was no longer enjoyable for some participants due to the restrictions and also reactions from fellow shoppers. Participants acknowledged feeling guilty and embarrassed when they thought they were being judged for purchasing too much food.

It [shopping] were just hard work, harder work than [pre-COVID]... It was an event in your life, rather than you just going and getting what you needed (P14).

Everybody looked really angry, and quite aggressive. I couldn't get out of there fast enough. It was really depressing (P15).

I was embarrassed as well... I kept saying, "I'm not panic buying. It's just there's five of us. We're home all the time" (P5).

However, for some participants, shopping was a means of escape, somewhere they could leave the house for.

Back then, it was a highlight because it got you out of the house, a bit of peace and quiet as well (P10).

It was one of the few things, again, that you could do, wasn't it? I wasn't one of these people who avoided going to shops or supermarkets, for fear of catching COVID (P17).

DISCUSSION

This study revealed the food-related experiences and behaviors of families with primary school-aged children, during COVID-19 and the first national lockdown. As the government's policies restricted usual activities, families spent more time together over food, enjoying family meals, cooking more meals from scratch and involving children in cooking. The place of food within the home was elevated as it became a source of enjoyment, entertainment, and comfort in uncertain times. Food choice was less focused on convenience, and participants spent more time on food, e.g., planning, shopping, preparing, cooking, as well as buying more premium foods and making food more special.

It was evident that there were changes in commensality; parents and children ate together more often, and there was a shift in food routines, with more quality family time during meals. Eating together as a family also adjusted the food and meals eaten by participants with, for example a more substantial and leisurely evening meal. Increased commensality corresponds with a Canadian study (conducted in April-May 2020) of families with 4–8-year-olds, where parents ate together more with their children since COVID-19 (8). Likewise, a US study reporting similar findings, attributed this to increased parental presence in the home (42). Other studies (from the US and Australia) have reported increased family mealtimes and family connectedness over food during lockdown (12, 13). Such changes (including those observed in the present study) are important, not least because they afford the opportunity for parents to model good dietary habits, relevant in promoting for example, children's acceptance and willingness to try new foods (25); the potential for less favorable eating habits also applies however.

As well as favorable changes such as spending more time cooking and preparing meals from scratch, unfavorable changes also emerged. These included increased snacking. This has been reported previously in adults (43–47) and children (8, 10, 12, 43), including in UK surveys (48, 49). In the present study, increased snacking in children was attributed to boredom and being in an environment with ready access to food. This is in line with previous research which found that snack frequency in children was predicted by boredom, and children attempted to fill time or seek comfort from food during lockdown (9). Children's increased snacking warrants further attention, given the potential effects on nutritional status. Ignoring internal cues of hunger and instead, eating through boredom over a long period can induce weight gain (50). This is particularly pertinent given that predictions are that childhood obesity levels will increase due to the pandemic and may not be easily reversible (11, 51), and substantial increases in childhood obesity were reported for the 2020/21 school year in England (17).

Some parents attributed their own increased snacking to pandemic-related anxiety or worry. A study from New Zealand (47) highlighted adults' increased consumption of snacks during lockdown, and an overall shift to an unhealthy dietary pattern, with authors pointing to the need to mitigate stress in future responses by government and employers. More generally, snacking has been related to opportunity-induced eating and coping with negative emotions (52), with emotional eating theory, suggesting negative emotions induce eating, as eating can reduce negative feelings through psychological and physiological mechanisms (53). Related to COVID-19 and the restrictive measures, increased stress and a decline in mental health has been recognized – with a deterioration in mental health in UK adults as the pandemic emerged in spring 2020 (20). Previous work has indicated that COVID-19 restrictions and fears over illness potentially increased anxiety and lead to stress-related

eating, particularly foods high in sugar and fat (54). A UK survey found that during the pandemic, adults ate more chocolate, cakes or biscuits, and crisps when feeling tired, stressed, bored or anxious (55).

Interestingly, many parents in the present study attempted different strategies to control children's snacking, including restriction, providing healthier alternatives, and other means such as a snack menu board with limited "money" to spend. Parents also reported using food as an incentive or to control behavior. Previous research from the US reported various parenting practices during the pandemic, such as more snack planning and more emotion-based snack feeding, and exerting more control when experiencing high-stress levels (42). Further, increased stress levels in parents during lockdown in a French study were found to predict greater increases in giving children autonomy regarding how much to eat and, according to the researchers, parents may have become too permissive regarding the food offered (9). Supporting parents to promote good dietary practices and routines is important, with for example, an understanding that children learn to positively associate food with feelings generated from a reward, and that this might affect overeating and weight gain (56, 57). Likewise, support regarding food parenting practices is important alongside an appreciation that the extremes of complete coercive control or full relinquishment of control to the child can have negative effects, with the ideal being control through guided choice (58).

In this study, parents recognized children's increased food choice autonomy; children chose their own and their family's food more often and were more involved in food preparation. The parents in this study also reported involving their children in meal preparation more, which children enjoyed. It is interesting to note that some of the changes arising out of lockdown, for example, child involvement in meal preparation, which has been associated with healthier diet consumption (59), have the potential to promote healthy eating. Interestingly, an uptick in packed lunches (when schools reopened) was apparent in the present study; this may be related to changes with how school lunches were provided at this time, as well as greater food choice autonomy during lockdown, and children wanting to maintain more input into their lunch.

Food became more important to families in this study, and parents spent more time planning and preparing meals (including from scratch) and sought new recipes; they also gained satisfaction in spending time providing "healthier" meals to the family. Increased planning and preparation of home-cooked meals and cooking from scratch (8, 9, 13, 60–62) and perceived healthier eating during lockdown have been found in other studies (8, 63). Likewise, a UK study examining food choice motivations during the pandemic found that ease of preparation became less important, and family involvement more important to parents and carers (64).

Over time however, food preparation became monotonous, and for a break from the usual routine and to make mealtimes more enjoyable, participants bought more premium foods and had takeaways more often. Increased takeaways during lockdown due to boredom with your own home-prepared food has been reported elsewhere (13). This differs from a survey which reported a decrease in takeaway food consumption during lockdown (65); however, only 27% of survey respondents had children under 16 years, and it is possible that having to prepare family meals for children, as in the present study, led to more fatigue in this respect, driving takeaway orders.

As the pandemic continued and food businesses reopened, participants did not resume their pre-lockdown rates of eating out, and instead focused on takeaways. Parents felt it was not as safe or as pleasant to eat out due to the restrictions in place. This corresponds to findings from a US survey (administered in October 2020) of families (61) reporting that takeaway was perceived as safer (than eating in restaurants), and increased during COVID-19. Takeaway food has been found to be excessive in portion size, energy, macronutrients, and salt (66). The impact on nutritional status of increased takeaways during the pandemic and beyond should be examined, including consideration of their replacement of eating out.

In the present study, parents reported using online shopping and deliveries because of changes in the retail food environment and government restrictions. In the UK, reduced food availability in shops influenced food choice during the pandemic, and food systems were initially put under pressure as consumer purchasing habits changed (67). Periods of panic buying resulted in stockpiling and hoarding, which resulted in shortages of some items (68). Online food shopping increased, as many tried to avoid exposure to other people (69, 70). A relocalisation of food was also evident in this study, with participants turning to local food retailers and shopping more locally, reflecting trends for more localized food purchasing during the lockdown, as reported by the Food Standards Agency (49). Likewise, UK consumer data has revealed sales of food for home consumption increased, out of home food sales reduced, with increased use of local food retail (71, 72). Localized food shopping has also been reported in Italy (73) and in France (9). Further, it has been suggested that relocalisation was likely to be sustained with the work from home and distancing restrictions in place (67).

As well as shopping more locally, participants shopped as infrequently as possible, discarding the usual "nipping to the shops". This was driven by fear of visiting shops too often, and similar findings were reported in an Australian study (13). Avoidance of shopping also led to reduced household food waste, as participants delayed needing to shop by saving and reusing leftover food. Reduced food waste was also attributed by participants to meal planning and list-making. Previous research from Spain has reported that reduced food waste during the COVID-19 lockdown was related to reduced shopping frequency, improved food management and preparing more creative recipes with leftovers (62). Likewise, changes in household food management and reduced food waste has been reported in Italy (73, 74) and New Zealand (75). Further, participants in the present study discussed food waste in relation to concerns over food access and availability, corresponding with a Tunisian study (76) which suggested that reduction in food waste during COVID-19 lockdown was likely to be driven by socioeconomic factors rather than environmental concern.

Interestingly, many of this study's insights suggest that the stay-at-home policies in place during the national lockdown

may have provided the opportunity for improved food literacy. Many changes reported by participants (such as cooking from scratch more, seeking different recipes and trying new foods and better food management) point to spending more time with food, becoming more skilled in food preparation, and gaining more knowledge about food. Likewise, a greater ownership of food and feeling good about providing healthier meals for the family, as well as more localized food shopping may propagate a deeper understanding of the importance of food and its role in social relationships with others and thinking about where food comes from, when considering supporting the local economy. Many of these relate to the components of food literacy, such as the planning and management, selection, preparation, and eating of food (77), and food-related skills and knowledge (78). Food literacy is important for individuals to navigate the complex food systems and can help to ensure food intake is in line with nutritional recommendations. The proposed change in food literacy in this study is supported by evidence from other research. In a study of 38 countries (79) food literacy behaviors of planning, selecting and preparing healthier food were higher during COVID-19 restrictions. Likewise, a cross-sectional study (80) reported that Canadians became more food literate (trying new recipes and new ingredients) since the pandemic. Many of the changes reported in the present study and the increased emphasis on food can be viewed overall as positive, however given the complex relationship between food and eating behavioral disturbances, this may not be the case for all individuals.

COVID-19 restrictions presented challenges to participants' usual food-related practices. Closure of food service outlets (e.g., cafes, restaurants) emphasized food preparation and consumption at home. Shortages of certain foods and changes to the retail food environment contributed to the adoption of new shopping behaviors. Participants recognized increased snacking for themselves and their children, attributing the latter to boredom or food availability at home. Government restrictions removed social interaction over food with, for example friends, peers, colleagues and extended family. The various influences on participants' behavior correspond to different levels of the socioecological model (18), for example more proximal influences affecting snacking, whilst distal influences at a policy level with respect to food shopping restrictions and reduced commensal eating with friends and colleagues. The pandemic's influence on diet and nutrition has been reported to have gone beyond the individual and community, reaching national and global levels of the ecological model (81). Further, it is proposed that behavior will have been unusually influenced by more distal levels than would be expected in other food choice transitions, given the nature of the pandemic and national lockdowns.

Strengths and Limitations

The study's strength comes from incorporating both parent and child perspectives and experiences during lockdown, providing a rich picture of the home food environment at this unique time. Using remote video interviews widened participation to individuals who may have otherwise had time or place constraints. Conversely, it may have inadvertently excluded participants with limited access to the technology or competency required to participate (82). Further, whilst verbal and non-verbal cues are detectable; it can be challenging for the interviewer and the interviewee (83) particularly considering subtle non-verbal cues, and the reduced frame of a headshot restricting observation of participants' body language (84).

The limitations of this study should be acknowledged, and these include sample bias, e.g., potentially higher response rate from families interested in food or with healthier eating habits. The study data is derived from participants' recollections of lockdown and could be subject to recall bias. This bias may be more pronounced with child participants whose recollection of lockdown was not as clear as parents. Further, researcher-led interviews may have led to social desirability bias with participants saying what they think the interviewer wanted to hear.

In considering this study's findings attention should be given to the demographic characteristics of the sample population, which was almost exclusively mothers (95%), white British (95%), and educated to degree level (75%). Although there was a range of household incomes, half of households were earning £75,000 plus, i.e., at least twice the average household income in the UK. This is particularly relevant, given for example, better education levels and higher household income have been shown to be relevant to better food literacy skills (85, 86). Further studies to explore perspectives and perceptions of families from different backgrounds and with different demographic characteristics (such as ethnicity, education, household income) would be valuable, particularly as responses to COVID-19 may be sensitive to socioeconomic characteristics.

The potential impacts of changes on nutritional status, for example cooking from scratch, snacking, should be explored. Greater understanding of both favorable and unfavorable shifts to dietary behaviors will be valuable in informing public health interventions targeting families. Special consideration should be given to how lockdown may have impacted food literacy, and if learnings can be applied beyond the pandemic to improve food literacy and nutrition status for families. Incorporating, for example, food skills, cooking confidence and nutrition education, within efforts to support individuals to implement or develop some of the positive aspects seen in this study, is worthy of further examination.

It is unclear whether the effect of further lockdowns and the continuing pandemic will result in longer term shifts in behavior, and for example more reliance on the local food retail sector may persist. It may be that some of the changes (e.g., shopping frequency) initially driven by fear, apparently subside with usual habits returning. Further research, including across socioeconomic groups, is necessary to ascertain the longevity of changes and to understand any lasting shifts in behavior. This is particularly relevant given the nutritional implication of some changes (e.g., increased snacking) and the possibility of working from home and flexible working in the future.

CONCLUSIONS

To conclude, this study has revealed how, as the government's lockdown policies restricted usual activities, families spent more time together over food, enjoyed eating family meals together, cooked more meals from scratch and involved children in cooking more. As well as favorable changes reported by parents and children (spending more time together, more time cooking and preparing meals from scratch, more efficient shopping, and less food waste), unfavorable changes also emerged including increased snacking. The place of food was elevated in families' homes and overall, findings point to improvements in food literacy. The longevity of changes should be investigated, particularly given the potential implication on the nutritional status of families.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because of ethical restrictions.

ETHICS STATEMENT

Ethical approval for this study was granted through the Faculty Research Ethics Committee. Parents provided their written informed consent to participate in this study, and for their children to participate in this study.

AUTHOR CONTRIBUTIONS

HE conceived the study. LS wrote the original manuscript. HE and LS designed the study, conducted the data collection, analysis, reviewed, and approved the final manuscript. Both authors contributed to the article and approved the submitted version.

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Household Mealtimes During the 2020 COVID-19 Lockdown in Aotearoa New Zealand: The Influence of Household Type and Psychological Distress

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COVID-19 lockdown meant disruptions to daily routines for households in Aotearoa New Zealand. The research presented here investigates how mealtimes changed for people living in New Zealand during the first COVID-19 lockdown in mid-2020 and sought to determine if household composition type and psychological distress impacted the frequency of engaging in several mealtime behaviors. The COVID Kai Survey collected data using an anonymous, online survey and asked questions on sociodemographic characteristics including household composition, frequency of engaging in different mealtime behaviors before and during lockdown, and psychological distress, which was measured using the Kessler 6 screening tool. The findings of this study shows an increase in the perceived importance of mealtimes (n = 807, 26.9% before lockdown, n = 1,154, 38.5% during lockdown) and an increase in the proportion of the survey respondents who stated that they frequently ate meals at the dinner table (n = 1,343, 44.8% before lockdown, n = 1,481, 49.4% during lockdown). There was a decrease, across all household composition types, in the proportion of respondents who ate out frequently at a restaurant or café (n = 878, 29.3% before lockdown, n = 5, 0.2% during lockdown, $P < 0.001$). The use of meal kits, e-dining, and eating meals in front of screens is also presented and discussed. All results are discussed with reference to Aotearoa New Zealand's stringent lockdown restrictions. Respondents who experienced psychological distress during lockdown were 1.47 times more likely to consider mealtimes an important part of their day and respondents living in households with one adult and at least one child who also experienced psychological distress were 5.95 times more likely to eat dinner at the dinner table than those who did not report psychological distress. Findings of this study further the understanding of the wider societal impact of COVID-19 lockdown on everyday life.

Keywords: COVID-19, diet, mealtime, eating behavior, family, household, nutrition

INTRODUCTION

Aotearoa New Zealand had one of the most effective responses to COVID-19 worldwide, eliminating the virus for large parts of 2020 and 2021 (1, 2). To achieve this success, Aotearoa New Zealand had a particularly stringent lockdown during the period of the 25th of March to the 13th of May 2020 (3). Overnight, people had to limit their movements, schools shut, restaurants and retail stores closed with only supermarkets and pharmacies remaining open for essential food and medical supplies, and employees were instructed to work from home wherever possible. Consequently, people's habits and daily routines suddenly changed.

The COVID-19 crisis resulted in many changes to the way people prepared and consumed food and the variety of food they could access. During lockdown, New Zealanders had to cook for themselves, not meet up with others for social and culturally important meals, and contend with panic-buying (4), empty shelves at supermarkets and fear of infection. On top of spending more time at home, people had to deal with the uncertainty and additional stress that accompanies the current COVID-19 pandemic.

There is a growing evidence base to show that our eating behaviors change when we are stressed (5). Specific to the COVID-19 lockdown, many have experienced additional stress due to isolation and fear of infection, disruption to food supply chains, increased food insecurity, potential job losses and financial hardship (6). Previous coping mechanisms for times of stress and hardship such as sharing meals (4) may have been prohibited for some during lockdown. In response e-dining, the practice of engaging in a meal with other people electronically through Zoom, Facetime, or other video chatting software, emerged to help people feel connected to one another but without the obvious sharing of food (7).

Household composition is an important consideration of how society responds to crisis like COVID-19 because of the association between household composition and primary drivers of stress, particularly financial hardship and stress related to responsibilities such as caring for children and aging parents (8, 9). The groups most vulnerable to increasing food insecurity after a crisis are women, ethnic minorities, immigrants, single-parent households, and low-income families (10, 11). Household composition in New Zealand takes on a myriad of forms from single person households, to households with many adults and no children, to households with 1 or more adults and 1 or more children (12). The effectiveness of many of New Zealand's public health measures to control COVID-19 were centered on the household, specifically the ability to isolate and maintain physical distancing (13). Globally additional challenges, including purchasing and safely preparing healthy food, were faced by those living in overcrowded households or unhealthy housing during lockdown (14).

For many people, food is a way to mitigate or manage stress. Globally, people who reported less stress in lockdown had healthier overall eating behaviors and made healthier food choices than people who reported high levels of stress (15, 16). The practice of emotional eating and increased consumption of sugary, salty, and fatty foods are associated with increased stress levels during lockdown (17). In times of uncertainty, mealtimes can help people maintain a sense of normalcy and feeling connected to other people in their household (18). More frequent family mealtimes and more pleasant mealtime atmospheres are associated with a variety of positive health and wellbeing outcomes including better nutrition, higher social competence, and fewer emotional and behavioral problems (19, 20). Daily routines and the structure associated with regular mealtimes can help people manage stress and maintain healthy habits (20–22). Mealtime behaviors include things such as where an individual eats their meals (at the dinner table vs. in front of the television vs. at a restaurant), who they eat with (eating alone vs. eating with others), and where they acquire their meals (takeaway vs. cooking at home). However, there are many complexities associated with maintaining mealtime behaviors, such as time, disrupted food systems, lost income, and balancing other's needs, and caring responsibilities (11, 22, 23).

This research aimed to investigate how mealtimes changed for New Zealanders during the first COVID-19 lockdown in mid-2020, and determine if household composition type and psychological distress impacted the frequency of engaging in several mealtime behaviors.

MATERIALS AND METHODS

This study reports on the findings of the COVID Kai Survey, the New Zealand arm of the international Corona Cooking Survey developed by researchers in Antwerp, Belgium. The Corona Cooking Survey was conducted in 38 countries, and over 37,000 people participated in the survey worldwide, with the results of the international study presented in De Backer et al. (23). The survey was uploaded onto the Qualtrics survey platform for each participating country to run independently. The questionnaire included questions regarding grocery shopping habits, food stockpiling habits, food preparation, cooking habits, ready-made meals vs. fresh/from scratch, self-perceived cooking ability, barriers to cooking and baking, decision making regarding recipe choice, self-perceived top food-related influential figures/organizations/brands, a food frequency questionnaire, source of nutrition advice, eating behaviors, perceived importance of mealtimes, lockdown conditions, psychological distress, and questions concerning sociodemographic characteristics (23).

The Corona Cooking Survey was granted ethical approval by the Ethics Advisory Committee on Social and Human Science at the University of Antwerp on April 16th 2020 (ref: SHW_20_46).

The COVID Kai Survey

The Aotearoa New Zealand arm of the Corona Cooking Survey was called The COVID Kai Survey. It used exactly the same questions as the international version, only the invitation and introduction text were adapted to be appropriate to the population and culture of Aotearoa New Zealand. This was achieved by including Te Reo Mâori in the title, plus Statistics

New Zealand's standard ethnicity question was added to the questionnaire for ethnic group comparisons (24).

The COVID Kai Survey was released online in Aotearoa New Zealand on 24 April 2020 and remained open until 13 May 2020 (20 days total). During this time, Aotearoa New Zealand was under government-mandated Alert Level 3 and 4 restrictions. During Alert Level 4 restrictions in Aotearoa New Zealand, people were instructed to stay at home except for essential personal movement, and all businesses (except essential services) were closed. Grocery stores and pharmacies were open, but takeaway shops, restaurants and many small specialty food stores could not operate. During Alert Level 3 restrictions, schools remained closed, people were still instructed to stay within their household, some businesses could open with public health restrictions. Restaurants could open for contactless takeaway and delivery but could not open for dine-in meals.

The Aotearoa New Zealand arm of the study was granted ethical approval by the University of Auckland Human Respondents Ethics Committee on 24 April 2020 for 3 years (ref: 024607).

Recruitment

Recruitment for the survey was through convenience and snowball sampling and was promoted widely through social media. Stakeholders, public food figures and colleagues from related organizations disseminated the survey invitation amongst their networks, and the general public shared the survey's social media posts. Respondents were required to be aged 18 years or older and currently reside in New Zealand. Researchers monitored responses from demographic groups of interest multiple times during the data collection period. Facebook advertising was used to recruit groups with lower response rates, such as men and those aged over 65. After the data collection period closed, a NZ$3200 donation was given to The Foodbank Project (the Salvation Army) as koha (gift of gratitude) of $1 for each near-completed survey (24).

Aim and Objectives

This study sought to investigate how mealtimes changed for New Zealanders during the first COVID-19 lockdown in mid-2020.

In the objectives below mealtime behaviors refers to: the perceived importance of mealtimes, the frequency of eating at the dinner table, frequency of watching television or another screen while eating a meal, frequency of engaging in e-dining and use of meal service kits.

Objective 1: To determine if household composition type impacted the frequency of engaging in several mealtime behaviors during the first COVID-19 lockdown in mid-2020.

Objective 2: To determine if psychological distress impacted the frequency of engaging in several mealtime behaviors during the first COVID-19 lockdown in mid-2020.

Objective 3: To determine if there is an association between household composition type and psychological distress experienced by participants during the first COVID-19 lockdown in 2020.

Data Preparation

The COVID Kai Survey closed with n = 3,574 entries. n = 574 responses were removed from the final dataset due to implausible answers or not answering all relevant questions specifically: mealtime behaviors (n = 568), use of meal services (n = 2), and frequency of e-dining (n = 4). One respondent was removed as their stated age of 120 years was deemed implausible and so the accuracy of the rest of their responses was questionable. n = 3,000 responses are included in the analyses presented.

Variables

The original COVID Kai Survey contained 100 variables, including questions regarding perceived cooking ability, a food frequency questionnaire, and sources of nutritional advice, amongst other topics. Many of these variables have been discussed elsewhere (24–26).

The sociodemographic information collected included age, gender, ethnicity, highest education qualification, employment status before and during lockdown, financial struggle before and during lockdown, and whether respondents lost any income during lockdown. Respondents also shared the number of children and/or adults they were currently living with. These data were used to create the following household composition subgroups: single person households, households with 2 + adults and no children, households with 2 + adults and 1 + child, households with 1 adult and 1 + child. Age group categories were also created (18–29, 30–49, 50–69, 70 +) and ethnicity was coded following the guidelines published by the Ministry of Health, Health Information Standards Organization (27). When respondents included multiple ethnicities, the ethnic groups were prioritized according to Statistics New Zealand prioritization categories and only coded once, in line with common practice in Aotearoa New Zealand (28). The ethnic categories included in this analysis were "Māori," "Pacific," "Asian," and "New Zealand European/Other (NZEO)."

Psychological distress was measured using the questions from the Kessler-6 test (29). This six-item inventory uses a Likert scale to identify the level of psychological distress an individual is currently experiencing. The Kessler-6 test asks respondents to self-report how they have been feeling over the past 2 weeks; however, respondents were asked to answer the questions during the lockdown period for this survey, which was between 32 and 52 days, while the survey was open. The original Kessler-6 test is conducted using a 5-point Likert scale; the possible response options are "never," "a little of the time," "some of the time," "most of the time," and "all of the time." The data collected in the COVID Kai Survey was collected on a 7-point Likert scale; the possible responses were "never," "very rarely," "rarely," "sometimes," "frequently," "very frequently," and "all the time." To address this discrepancy, the responses from the 7-point scale were adjusted to best fit the 5-point scale used in the original Kessler-6 tool so that the same cut-point of 13 or greater could be used as the indicator of psychological distress (30). The responses "very rarely" and "rarely" were combined to become "a little of the time," and the responses "frequently" and "very frequently" were combined to become "most of the time."

The questions regarding mealtime behaviors included: asking respondents to rate how important mealtimes were for them and their household, how frequently respondents ate dinner at their dinner table, how frequently respondents watched television or another screen while eating a meal, and how frequently respondents engaged in e-dining. These questions had a 7-point frequency response scale ranging from "never" to "all the time." Respondents were asked to report their behavior on the scale twice, once at the time of survey completion (during lockdown) and once before the COVID-19 lockdown began.

The questions regarding the use of meal services included: asking respondents how often they eat out in a café or restaurant, how often they use delivery or takeaway services, and how often they use meal or ingredient boxes. Respondents reported their behavior before and during the lockdown using a 7-point Likert scale.

All data was collected cross-sectionally, during the lockdown. For some of the mealtime behavior questions, respondents were asked to recall their behavior before the lockdown and report their behavior at the time of survey completion. In the analysis of all mealtime behavior variables, the data were presented as binary categories (frequently or less than frequently). Variables such as frequency of e-dining and psychological distress were only collected for one point in time (at the time of the survey during the lockdown) and therefore analyzed for differences between groups. The responses for frequency of e-dining were grouped into three categories;(almost) never, once a week or less, and more than once a week.

Analysis

Three main types of analysis were conducted for this study: descriptive statistics, comparison of behaviors during lockdown to before lockdown, and differences in mealtime behaviors between household composition groups. All data were analyzed both for all survey respondents and broken down by household composition subgroups. Fisher exact and Wald tests were used to determine differences between household composition groups. Multivariate logistic regression, adjusted for demographic covariates, was run for four variables: perceived mealtime importance, frequency of eating at the dinner table, frequency of eating in front of a screen, and use of meal kit services. Covariates were decided *a priori* and included: household composition type, age group, gender, and ethnicity. The household group "households with 2 or more adults and 1 or more child" was chosen as the reference group for the regression as they had the largest sample size and likely had the best health outcomes.

The impact of psychological distress on mealtime behaviors was tested using logistic regression, predicting each behavior by psychological distress score.

All analyses were conducted in R Studio.

RESULTS

Sociodemographic Characteristics

The majority of survey respondents identified as female (n = 2,658, 88.6%). 30–49-years accounted for nearly half (n = 1,429, 47.6%) of all survey respondents. The largest ethnic group of respondents was New Zealand Europeans or Other (n = 2,472, 82.4%). Māori made up n = 315, 10.5% of the respondents. Asian and Pacific people made up the remainder of the participant ethnic groups (n = 132, 4.4%, and n = 81, 2.7%, respectively).

Around half of the respondents (n = 1,586, 52.9%) worked full-time before lockdown. A quarter of survey respondents (n = 774, 25.8%) stated that they had lost some or all their income during lockdown. Those living in households of multiple adults with no children experienced the greatest rates of lost income (n = 434, 27.1%). Those living in households with one adult and at least one child experienced the lowest rate of income lost (n = 9, 18.8%). Most respondents reported that they rarely or never struggled financially during lockdown (n = 1,809, 60.3%) with a smaller proportion (n = 298, 9.9%) reporting to have struggled financially often or all of the time and almost a third (n = 811, 27%) reporting they struggled to buy food during lockdown often or all of the time. The highest level of financial struggle were households with one adult and at least one child (n = 13, 27.1%). Detailed sociodemographic characteristics of survey respondents by household composition are presented in **Table 1**.

Mealtime Behaviors by Household Composition

There was an increase in the proportion of the survey respondents who stated that they frequently consider mealtimes to be an important part of their day during lockdown (n = 807, 26.9% before lockdown, n = 1,154, 38.5% during lockdown, $P \leq 0.001$). This was a significant increase among all household composition groups except for households with one adult and at least one child (P = 0.823). These changes remained significant after adjusting for age, gender, and ethnicity differences (**Table 2**).

There was an increase in the proportion of the survey respondents who stated that they frequently ate meals at the dinner table during lockdown (n = 1,343, 44.8% before lockdown, n = 1,481, 49.4% during lockdown, $P < 0.001$). This was a significant increase in households with multiple adults, both with and without children. However, once adjusted for age, gender and ethnicity, the change seen in households with multiple adults and no children was no longer significant ($P > 0.05$) (**Table 3**).

There was an increase in the proportion of the survey respondents who stated that they frequently ate meals in front of a screen during lockdown (n = 972, 32.4% before lockdown, n = 1,095, 36.5% during lockdown, $P < 0.001$). This remained significant in households with two or more adults after adjusting for covariates, but not single person households (**Table 4**).

There was a substantial decrease in the proportion of respondents who ate out frequently at a restaurant or café during the lockdown (n = 878, 29.3% before lockdown, n = 5, 0.2% during lockdown, $P < 0.001$). This was a significant decrease across all household composition subgroups ($P < 0.05$). There was a decrease in the proportion of respondents who frequently used delivery or takeaway services for main meals during lockdown among all respondents (n = 650, 21.7% before

TABLE 1 | Sociodemographic characteristics.

Descriptive statistic, *n* (%)	**Total sample**	**Single person households**	**Households with 2 + adults and no children**	**Households with 2 + adults and 1 + child**	**Households with 1 adult and 1 + child**
	3,000 (100)	292 (100)	1,601 (100)	1,059 (100)	48 (100)
Gender					
Female	2,658 (88.6)	262 (89.7)	1,414 (88.3)	938 (88.6)	44 (91.7)
Male	311 (10.4)	28 (9.6)	165 (10.3)	114 (10.8)	4 (8.3)
Gender diverse	31 (1.0)	2 (0.7)	22 (1.4)	7 (0.7)	0 (0.0)
Age group					
18– < 30	508 (16.9)	18 (6.2)	405 (25.3)	83 (7.8)	2 (4.2)
30– < 50	1,429 (47.6)	95 (32.5)	504 (31.5)	795 (75.1)	35 (72.9)
50– < 70	948 (31.6)	145 (49.7)	613 (38.3)	179 (16.9)	11 (22.9)
70 +	115 (3.8)	34 (11.6)	79 (4.9)	2 (0.2)	0 (0.0)
Ethnicity					
NZEO	2,472 (82.4)	263 (90.1)	1,343 (83.9)	826 (78.0)	40 (83.3)
Māori	315 (10.5)	15 (5.1)	142 (8.9)	151 (14.3)	7 (14.6)
Pacific	81 (2.7)	6 (2.1)	33 (2.1)	41 (3.9)	1 (2.1)
Asian	132 (4.4)	8 (2.7)	83 (51.8)	41 (3.9)	0 (0.0)
Employment status before lockdown					
Not working	453 (15.1)	62 (21.2)	244 (15.2)	141 (13.3)	6 (12.5)
Student with or without job	227 (7.6)	12 (4.1)	159 (9.9)	55 (5.2)	1 (2.1)
Worked part-time	734 (24.5)	55 (18.8)	323 (20.2)	341 (32.2)	15 (31.3)
Worked full-time	1,586 (52.9)	163 (55.8)	875 (54.7)	522 (49.3)	26 (54.2)
Employment status during lockdown					
Not working	672 (22.4)	78 (26.7)	364 (22.7)	218 (20.6)	12 (25.0)
Student with or without job	220 (7.3)	13 (4.5)	149 (9.3)	56 (5.3)	2 (4.2)
Worked part-time	804 (26.8)	63 (21.6)	368 (23.0)	361 (34.1)	12 (25.0)
Worked full-time	1,304 (43.5)	138 (47.3)	720 (45.0)	424 (40.0)	22 (45.8)
Income lost due to lockdown					
Yes, at least some	774 (25.8)	66 (22.6)	434 (27.1)	265 (25.0)	9 (18.8)
No	2,226 (74.2)	226 (77.4)	1,167 (72.9)	794 (75.0)	39 (81.2)
Struggled financially during lockdown					
Often or all the time	298 (9.9)	38 (13.0)	123 (7.7)	120 (11.0)	13 (27.1)
Sometimes	893 (29.8)	89 (30.5)	456 (28.5)	321 (31.0)	19 (39.6)
Very rarely or never	1,809 (60.3)	165 (56.5)	1,021 (63.8)	604 (58.0)	16 (33.3)
Struggled to buy food during lockdown					
Often or all the time	811 (27.0)	81 (27.7)	394 (24.6)	314 (29.7)	22 (45.8)
Sometimes	283 (9.4)	31 (10.6)	144 (9.0)	99 (9.3)	9 (18.8)
Very rarely or never	1,906 (63.5)	180 (61.6)	1,063 (66.4)	646 (61.0)	17 (35.4)

TABLE 2 | Frequently[a] found mealtimes important before and during lockdown.

	Before lockdown, *n* (%)	**During lockdown, *n* (%)**	***p*-value[b]**	**Adjusted[c] odds ratio (95%CI)**	**Odds ratio *p*-value[d]**
Single person (*N* = 292)	53 (18.2)	86 (29.5)	0.002	1.9 (1.41, 2.55)	<0.001
Households with 2 + adults (*N* = 1,601)	437 (27.3)	600 (37.5)	<0.001	1.29 (1.08, 1.53)	0.005
Households with 2 + adults and 1 + child (*N* = 1,059)	304 (28.7)	453 (42.8)	<0.001	1.00 (REF)	–
Households with 1 adult and 1 + child (*N* = 48)	13 (27.1)	15 (31.3)	0.823	1.64 (0.88, 3.06)	0.120

[a] *Frequently classified as responses "Frequently," "Very frequently," or "All of the time."*
[b] *Fisher's exact test.*
[c] *Adjusted for age group, gender, and ethnicity. Ref = households with 2 + adults and 1 + child.*
[d] *Wald's test.*

TABLE 3 | Frequently[a] ate meals at the dinner table before and during lockdown.

	Before lockdown, *n* (%)	During lockdown, *n* (%)	*p*-value[b]	Adjusted[c] odds Ratio (95%CI)	Odds ratio *p*-value[d]
Single adult (*N* = 292)	139 (47.6)	148 (50.7)	0.508	0.93 (0.71, 1.22)	0.609
Households with 2 + adults (*N* = 1,601)	722 (45.1)	782 (48.8)	0.037	1.02 (0.86, 1.22)	0.781
Households with 2 + adults and 1 + child (*N* = 1,059)	465 (43.9)	531 (50.1)	0.005	1.00 (REF)	–
Households with 1 adult and 1 + child (*N* = 48)	17 (35.4)	20 (41.7)	0.675	1.4 (0.78, 2.51)	0.246

[a] *Frequently classified as responses "Frequently," "Very frequently," or "All of the time."*
[b] *Fisher's exact test.*
[c] *Adjusted for age group, gender, and ethnicity. Ref = households with 2 + adults and 1 + child.*
[d] *Wald's test.*

TABLE 4 | Frequently[a] ate meals in front of a screen before and during lockdown.

	Before lockdown, *n* (%)	During lockdown, *n* (%)	*p*-value[b]	Adjusted[c] odds ratio (95%CI)	Odds ratio *p*-value[d]
Single adult (*N* = 292)	78 (26.7)	86 (29.5)	0.519	1.7 (1.27, 2.28)	<0.001
Households with 2 + adults (*N* = 1,601)	440 (27.5)	529 (33.0)	<0.001	1.48 (1.24, 1.77)	<0.001
Households with 2 + adults and 1 + child (*N* = 1,059)	437 (41.3)	465 (43.9)	0.235	1.00 (REF)	–
Households with 1 adult and 1 + child (*N* = 48)	17 (35.4)	15 (31.3)	0.829	1.69 (0.9, 1.46)	0.1

[a] *Frequently classified as responses "Frequently," "Very frequently," or "All of the time."*
[b] *Fisher's exact test.*
[c] *Adjusted for household type, age group, gender, and ethnicity.*
[d] *Wald's test.*

lockdown, $n = 22$, 0.7% during lockdown, $P < 0.001$). This was a significant decrease across all household composition subgroups ($P < 0.001$) (**Table 5**).

There was an overall increase in the number of respondents who stated they used meal kit services for main meals during lockdown ($n = 293$, 9.8% before lockdown, $n = 359$, 12.0% during lockdown, $P = 0.007$). Single person households were half as likely to use meal kit services as the household composition group with 2 or more adults and children (AOR: 0.54, $P = 0.014$) (**Table 6**).

Survey questions asked about respondents' experience of e-dining during the lockdown period. Respondents were asked to respond to the prompt *'since your lockdown began, how often have you organized or participated in dinner with someone via online video chat?'*. Most of the survey respondents ($n = 2{,}639$, 88%) responded that they "(Almost) never" organized or participated in dinner with someone via online video chat (e-dining) during lockdown. One in ten respondents ($n = 317$, 10.6%) had engaged in e-dining once a week or less during lockdown, and 44 (1.4%) e-dined more often than once a week. There were no significant differences between the household composition groups in the frequency of e-dining ($P = 0.604$). Single-parent households were excluded from the analysis of attitudes toward e-dining, as the sample size of respondents in that group was too small to draw conclusions from ($n < 5$).

Psychological Distress During Lockdown

Figure 1 presents the proportion of respondents experiencing psychological distress during lockdown (a score of 13 or more on the Kessler-6) by household composition group. The total scores amongst all respondents ranged from 6 (the lowest possible score) to 30 (the highest possible score). Just over half ($n = 1{,}636$, 54.5%) of all respondents self-reported a score of 13 or higher and among those the results varied between household composition groups from $n = 136$, 46.6% in the single person household group to $n = 29$, 60.4% in the single-parent households.

Respondents who experienced psychological distress during lockdown were 1.47 (95% CI 1.26–1.72, $P < 0.001$) times more likely to consider mealtimes an important part of their day than those who scored 12 or fewer. They were also 1.25 (95% CI 1.07–1.45, $P = 0.004$) times more likely to frequently eat dinner at the table and were 1.19 (95% CI 1.02–1.40, $P = 0.029$) times more likely to eat dinner in front of a screen or television. There were no significant differences by levels of psychological distress for those who frequently used meal kit services (AOR: 0.97,95% CI

TABLE 5 | Frequently[a] used delivery or takeaway services before and during lockdown.

	Before lockdown,*n* (%)	During lockdown,*n* (%)	*p*-value[b]
Single adult (*N* = 292)	44 (15.1)	6 (2.1)	<0.001
Households with 2 + adults (*N* = 1,601)	351 (21.9)	12 (0.7)	<0.001
Households with 2 + adults and 1 + child(*N* = 1,059)	240 (15.0)	4 (0.4)	<0.001
Households with 1 adult and 1 + child(*N* = 48)	15 (31.3)	0 (0.0)	<0.001

[a]*Frequently classified as responses "Frequently," "Very frequently," or "Every time I ate a warm meal."*
[b]*Fisher's exact test.*

TABLE 6 | Frequently[a] used meal box or ingredient kit services before and during lockdown.

	Before lockdown, *n* (%)	During lockdown, *n* (%)	*p*-value[b]	Adjusted[c] odds ratio (95%CI)	Odds ratio *p*-value[d]
Single adult (*N* = 292)	19 (6.5)	20 (6.8)	1.0	0.54 (0.33, 0.88)	0.014
Households with 2 + adults (*N* = 1,601)	125 (7.8)	159 (9.9)	0.040	0.79 (0.61, 1.02)	0.071
Households with 2 + adults and 1 + child(*N* = 1,059)	144 (13.6)	168 (15.9)	0.158	1.00 (REF)	–
Households with 1 adult and 1 + child(*N* = 48)	5 (10.4)	12 (25.0)	0.107	1.76 (0.89, 3.48)	0.105

[a]*Frequently classified as responses "Frequently," "Very frequently," or "Every time I ate a warm meal."*
[b]*Fisher's exact test.*
[c]*Adjusted for household type, age group, gender, and ethnicity.*
[d]*Wald's test.*

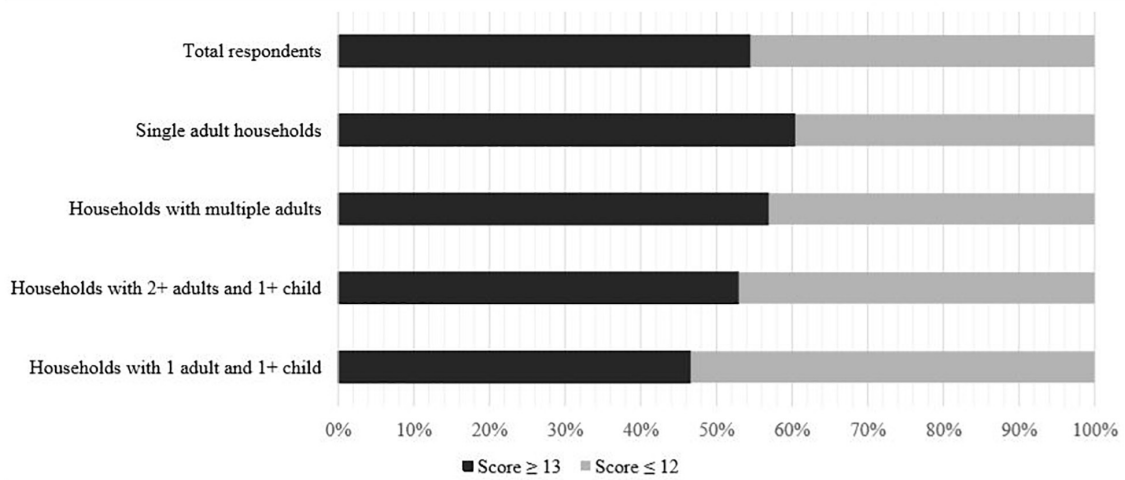

FIGURE 1 | Respondents experience of psychological distress during lockdown.

0.77–1.22, $P = 0.794$) or engaged in e-dining (AOR: 1.03,95% CI 0.81–1.30, $P = 0.811$).

Table 7 details associations between psychological distress and mealtime behaviors by household type. In households with multiple adults but no children, those with psychological distress were 1.60 times (95% CI 1.28–1.99, $p < 0.001$) more likely to consider meals an important part of their day than those who scored a 12 or below. In households with two or more adults and at least one child, those with psychological distress were significantly more likely to consider mealtimes an important part of the day (AOR: 1.30, 95% CI 1.02–1.67, $p = 0.037$), eat dinner at the dinner table (AOR: 1.4, 95% CI 1.10–1.8, $P = 0.007$), and eat dinner in front of the television (AOR: 1.45, 95% CI 1.13–1.86, $P = 0.004$) compared to those who scored 12 or below. In households with two or more adults and at least one child, the group who scored 13 or above were 0.65 (95% CI 0.44–0.96, $P = 0.029$) times less likely to engage in e-dining than those who scored 12 or below. In households with one adult and at least one child, those with psychological distress were 5.95 (95% CI 1.47–24.14, $P = 0.012$) times more likely to eat dinner at the dinner table frequently than those who scored 12 or below (**Table 7**).

DISCUSSION

The findings of this study indicate that the mealtime behaviors of cooking meals at home and eating meals at the dinner table increased during the first COVID-19 lockdown in Aotearoa

TABLE 7 | The impact of psychological distress during lockdown on mealtime behaviors.

	Single person households	Households with 2 + adults and no children	Households with 2 + adults and 1 + child	Households with 1 adult and 1 + child
Frequently[c] considered mealtimes to be an important part of the day				
Crude odds ratio (95%CI)	1.50 (0.90, 2.50)	1.58 (1.29, 1.94)	1.29 (1.01, 1.65)	2.29 (0.66, 7.95)
Adjusted[a] odds ratio (95%CI)	1.62 (0.92, 2.87)	1.60 (1.28, 1.99)	1.30 (1.02, 1.67)	1.92 (0.51, 7.27)
P-value[b]	0.095	<0.001	0.037	0.338
Frequently[c] ate dinner at the dinner table				
Crude odds ratio (95%CI)	0.94 (0.60, 1.49)	1.10 (0.91, 1.35)	1.35 (1.06, 1.72)	4.50 (1.31, 15.32)
Adjusted[a] odds ratio (95%CI)	0.86 (0.52, 1.43)	1.17 (0.95, 1.45)	1.4 (1.10, 1.80)	5.95 (1.47, 24.14)
P-value[b]	0.563	0.138	0.007	0.012
Frequently[c] ate dinner in front of the television				
Crude odds ratio (95%CI)	0.94 (0.57, 1.56)	1.05 (0.85, 1.3)	1.38 (1.08, 1.76)	0.68 (0.19, 2.43)
Adjusted[a] odds ratio (95%CI)	0.92 (0.53, 1.59)	1.06 (0.85, 1.33)	1.45 (1.13, 1.86)	0.65 (0.16, 2.7)
P-value[b]	0.758	0.592	0.004	0.554
Frequently[c] used meal kit or ingredient box services				
Crude odds ratio (95%CI)	1.16 (0.47, 2.87)	1.28 (0.91, 1.80)	0.87 (0.63, 1.21)	1.43 (0.36, 5.63)
Adjusted[a] odds ratio (95%CI)	0.75 (0.27, 2.06)	1.13 (0.79, 1.61)	0.84 (0.60, 1.18)	1.26 (0.29, 5.37)
P-value[b]	0.577	0.517	0.324	0.758
Engaged in e-dining during the lockdown[d]				
Crude odds ratio (95%CI)	2.27 (1.17, 4.4)	1.56 (1.14, 2.14)	0.70 (0.48, 1.03)	-[e]
Adjusted[a] odds ratio (95%CI)	1.53 (0.73, 3.17)	1.23 (0.88, 1.73)	0.65 (0.44, 0.96)	-[e]
P-value[b]	0.257	0.226	0.029	-[e]

[a] *Adjusted for age, gender, and ethnicity.*
[b] *Wald's test.*
[c] *Frequently included the responses "frequently," "very frequently," and "all of the time."*
[d] *Included all respondents who reported engaging in e-dining at least once during the lockdown.*
[e] *Households with one adult and one or more child excluded from analysis of e-dining due to low response numbers.*

New Zealand for all groups and especially for those in households with children and for participants who experienced psychological distress. Eating out and getting takeaways massively decreased for all participants over this period.

The Rise in Meal Kits and Decrease in Takeaways

The findings of this study show an overall increase in the perceived importance of mealtimes and an increase in meals cooked and prepared at home. Subsequently the use of meal kit services also increased during the lockdown period. The use of meal kits or ingredient box services may indicate that people were cooking more meals at home, as meal kit services were delivered to the household address with recipes and all necessary ingredients included. A study by Romeo-Arroyo et al. (16) explains that during confinement, the amount that a person cooks is dependent on their perception of cooking as either a pleasure or a duty. When cooking for oneself, there is less enjoyment in the process of cooking a meal, whereas cooking for or with others can be a form of entertainment and strengthens social bonds (16, 31, 32). Carroll et al. (32) discuss that during the COVID-19 lockdown in Canada, parents used cooking to bond with children, keep them busy, and reduce screen time. Meal kit use was greatest in households with children compared to households without children, which may be due to the added time pressures on adults who need to balance work and childcare responsibilities alongside the ease of children being engaged in the process of preparing meals.

The Aotearoa New Zealand COVID Health Survey found that at the beginning of the first lockdown in April 2020, 26% of respondents reported feeling stressed about leaving home, thus making grocery shopping more challenging (33). An alternative option would be getting one's groceries delivered by the store. However, in Aotearoa New Zealand there were long wait times for grocery deliveries as many people wanted to use the service and grocery stores were prioritizing populations with the most need, such as the elderly and disabled (34). Meal boxes were an alternative option for people who were unable to get their groceries delivered and were hesitant to visit the grocery store during lockdown. A possible explanation for why meal kit use was lowest in single-person households may be that most ingredient boxes are designed for at least two people. Purchasing a meal kit just for one person may not be financially viable and/or result in greater food waste (26). Meal kits would benefit from including information about how to modify recipes to reduce energy intake or suggest alterations in portion size for those with lower energy requirements or one person (35).

Before lockdown, 29.3% (n = 878) of respondents stated that they ate out frequently, and 21.7% (n = 650) reported frequently getting takeaways. These proportions decreased immensely during lockdown most likely because the lockdown restrictions in Aotearoa New Zealand meant that restaurants and cafes

were not allowed to open at all during Level 4, although they were able to open for takeaway and contactless delivery during Level 3. So, it would not have been possible for respondents to frequently eat out. However, the significant decrease in takeaway and delivery services cannot totally be explained so easily, as 66.6% of the COVID Kai Survey responses were collected during Level 3 restrictions (24), meaning that takeaway services were available for most people when they completed the survey. Studies about lockdowns in other countries also found that people are less likely to eat takeaway food during lockdown (10, 32), with concerns about price, safety, or greater motivation to eat healthy foods as potential reasons why takeaway use decreased for our survey respondents during the lockdown. However, anecdotal evidence shows that many businesses were swamped with customers once they opened for takeaways at the start of Level 3 (36). Therefore, the low numbers of people who reported eating takeaways frequently may be an outcome of the survey population demographics rather than an accurate representation of Aotearoa New Zealanders eating behaviors during lockdown.

Increased Mealtimes at the Table but Also Still Eating in Front of Screens

This study found an increase in the frequency of households eating at the dinner table during lockdown, and an increase in the perceived importance of mealtimes. This may be because during lockdown many people felt that they were missing a sense of routine (37) and mealtimes provide a sense of routine that was otherwise missing without school/work. Engaging in a routine, such as eating dinner at the table, has also been shown to be a coping strategy for people in times of stress and give people a sense of task-accomplishment (38, 39). Findings from the USA indicate that eating meals regularly at the dinner table gave respondents a sense of normalcy and acted as an important grounding time during the uncertainty of COVID-19 (40). In this study, households with two or more adults and children had the largest increase in eating at the table more frequently. Eating meals at the table has been shown to benefit adults and children because it is related to making healthier food choices, increasing family connection, improving mental health outcomes, and discouraging engagement in high-risk behaviors such as alcohol abuse (21). This may explain why respondents who experienced psychological distress and who resided in households with children experienced the largest increase in eating at the table more frequently.

Eating in front of a screen is not considered healthy eating behavior as this is associated with increased dietary intake and the inability to notice when you are full (41–43). For households of more than one person, screen use during mealtimes may be considered harmful as it creates a barrier to connect with others (44). Single person households and households with multiple adults and no children were significantly more likely to eat meals in front of the television than households with 2 or more adults and children, whereas households with children were more likely to eat dinner at the table. It has been found that during COVID-19 lockdowns globally, overall screen time increased so it makes sense that respondents reported spending more time eating in front of screens (45–47).

E-dining grew in popularity during lockdown whereby people in different households could eat together while on video conferencing software. This acted as a mode of social interaction during a time of physical distancing and isolation. There were anecdotal stories that some people began to hold virtual dinner parties to maintain some form of food-related socialization (48). However, our results found that only 12% of respondents reported e-dining regularly. Although e-dining is a mode of social interaction, it may only fulfill some of the benefits of face-to-face meal sharing. Some of the protective elements transferable to e-dining are; socialization, support, a strengthened sense of community, and a sense of control and normalcy in uncertain times (40). What is missing from e-dining is the actual sharing of food and resources alongside the opportunity to meet new members of the community and develop connections. For e-dining, one generally needs to be invited to an online meeting room, so those participating will most likely already know each other. There are also some general barriers to e-dining that may answer why so few people engaged in the behavior. For example, to engage in online meal sharing, a person must have access to a computer with a microphone and a camera and a reliable internet connection. These barriers mean that financially disadvantaged people may have limited access to e-dining even though they are the group that traditionally has benefitted most from meal-sharing practices during a crisis (49–51). This survey was administered during the first major lockdown in Aotearoa New Zealand. People were still grappling with it and had not yet relaxed into a COVID-19 world. There is the potential that if this survey were repeated during the subsequent lockdowns, e-dining would have been more common.

Single-Parent Households Had the Highest Stress and This Was Associated With Beneficial Mealtime Behaviors

During crises, psychological distress can arise from financial insecurity, food insecurity, general uncertainty, isolation, exacerbation of previous mental health conditions, and/or an insecure home life. All of these factors were relevant during the first Aotearoa New Zealand lockdown. Our results also showed a decrease in people engaged in full-time employment among all household groups and an increase in people who did not work during lockdown. A scoping review of the impact of eating behaviors during recent crisis indicates that precarious employment is a critical factor in stress levels and negatively impacts eating behaviors (52). This is important to consider for COVID-19, as many industries shut down, and at its worst in September 2020, approx. 151,000 people in Aotearoa New Zealand were unemployed. This represents a 32.5% increase since the end of the previous quarter in June 2020, a rise attributed to the impact of COVID-19 (53).

Single parent households had the highest levels of financial struggle during lockdown, yet they also reported the lowest levels of income lost, most likely because a high proportion of

single parent households receive government welfare payments (54). In Aotearoa New Zealand single-parent households are on average financially worse off than other types of households, and in 2020, 18% of single-parent households did not have enough money to meet their everyday needs (55). Our results showed that among all household types single parent households reported the highest levels of self-reported psychological distress. This may be explained because distress is highest in situations where people are financially insecure and also because of the stress of balancing the demands of working from home while also being solely responsible for child care and home schooling (56). Our findings of increased psychological distress among single parent households align with international research where parents have reported increased stress during the COVID-19 lockdown (56–58). Reasons for this are reportedly to relate to school closures and the difficulty faced working from home (57), alongside financial hardship and concern over children's mental and physical health (58, 59).

Psychological distress experienced in all households with children during the lockdown appears to have been accompanied by increases in beneficial mealtime behaviors, such as eating at the dinner table. This is consistent with previous research conducted in times of crisis showing that parents will utilize the skills they have available to them; specifically installing routines and it is possible parents capitalized on the lockdown to spend quality time together as a household (19). Findings of children's perceptions of lockdown in Aotearoa New Zealand reveal that children loved the additional time lockdown afforded them to spend with parents and household members (60). It is also possible that these increases in beneficial mealtime behaviors occurred as a result of decreased meals consumed outside of the home, in restaurants, cafes and takeaways eaten in the car or in a public place, but further research is necessary to explore these connections and confirm directionality.

Strengths and Limitations

To the authors' best knowledge this research is the first to explore changes to mealtime behaviors during the COVID-19 lockdown in Aotearoa New Zealand and the first to report a significant increase in beneficial mealtime behaviors, such as eating meal at the dinner table and decreased eating out among single parent households and among those experiencing psychological distress. The timeliness in which this study was completed is a strength of the research. The COVID-19 pandemic is rapidly changing and remains a contemporary influence on people's ability to acquire food and will likely remain an influence on stress and mealtime behaviors for some time to come (61, 62).

A further strength of the study is that the data was collected whilst Level 3 and 4 lockdowns were still in place. Although the data collection methods were retrospective and self-reported, respondents answered questions while still in the period of interest. Consequently, the results likely reflect the lockdown experience as it was fresh in the respondent's minds. Overall, the study had a high participation rate given it was conducted during a period of uncertainty and restricted movement. In comparison to other countries that participated in the Corona Cooking Survey project, the Aotearoa New Zealand branch had significantly higher response numbers per head of population (23). The online format of the COVID Kai Survey meant respondents did not have to take any risks in terms of safety regarding COVID-19 in order to participate.

Funding was obtained that allowed for a $1 koha to be donated to the Aotearoa New Zealand Food Bank for every response collected. This was a strength of the research as it gave New Zealanders an additional reason to participate in the study, as well as an opportunity to do something beneficial in a time when many people felt helpless (63). It is also considered good practice for research initiatives to give back to the community from which they collect data rather than simply taking from it.

One of the main limitations of this study is that the respondents were not representative of the Aotearoa New Zealand population. Respondents were primarily well-educated, New Zealand European people who identified as women. There was a very low representation of Pacific people and gender diverse people. The use of an online survey format promoted through social media favored people with privilege. Online data collection is not suitable for collecting information about Māori and Pacific people due to cultural barriers (64). To effectively engage with Māori and Pacific people, it is necessary for researchers to take the time to build authentic relationships through face-to-face engagement. Unfortunately, due to the physically distanced nature of the COVID-19 lockdown this was not possible. Zoom interviews could have been a potential way to establish these relationships in a COVID-19 friendly way (65). The COVID Kai research team worked with cultural organizations to develop advertisements for the survey in Te Reo Māori and a variety of Pacific languages and promoted the survey through their networks. However, this was ultimately unsuccessful at recruiting sufficient numbers to be representative of the national population.

Even for English speakers, the survey required a high literacy level to complete and had a significant participant burden, taking around 30 min. If this study were repeated, it would be helpful to amend the questions to be more appropriate for the Aotearoa New Zealand population and consider other modes of data collection such as targeted phone, text message or Zoom interviews. Offering a larger koha directly to the participant may also incentivize more people to contribute. The household group distributions were also not representative of Aotearoa New Zealand; the single-parent household group had a low response number, even though one-third of families in Aotearoa New Zealand are headed by a single parent (66). This may be because sole parents and their children moved in with their extended families during lockdown, or they were just too stressed or busy to be able to dedicate sufficient time to participate.

Another limitation of the findings is that the Likert scales as response categories had no clear guidance as to what each point on the scale meant. The responses were likely interpreted differently by different individuals (67). For example, what one respondent would have considered "rarely" engaging in a

behavior, another may have considered "sometimes." To simplify the results and avoid bias associated with misinterpretation of the scales, the results were collated into binary categories, "less than frequently" and "frequently or more" in the analyses presented but this would have resulted in lost detail.

Due to the retrospective and self-reported nature of the "before-pandemic" questions asked, there is potential bias in the data collected. Self-reported data, particularly about food and eating behaviors, has the potential for bias due to selective recall and social desirability impacting what a respondent chooses to report (68). Often unhealthy and less socially desirable behaviors are not as easily recalled and thus are underreported (68). However, people are more likely to be honest in surveys when they are completed independently, as opposed to through face-to-face interviewing (69). Selective recall can also be due to respondents re-evaluating their own behaviors over time and choosing not to disclose some details (68). This is particularly common in nutrition studies as food choice is a sensitive topic and people will often modify their responses in order to come across as healthier (68, 70). This is also often the case in research conducted on parenting where answers may be edited for social desirability (71). This issue was minimized somewhat by the short recall period and by assuring respondents that all data collected was anonymous.

Additionally, one of the main measures in the study was psychological distress. However, no potential positive psychological aspects of lockdown were measured. A large study of Māori conducted at the same time as the COVID Kai Survey found 19.5% of responders reported positive whānau (family) outcomes and 17.1% reported positive psychological outcomes due to the COVID-19 lockdown, with nearly 14% reporting that lockdown gave people an opportunity to stop and reflect on their lives (72). Children too reported that they liked many aspects of lockdown including the slower pace of life and the increased time spent with family doing simple everyday activities such as going for bike rides in their neighborhood, pajama days and playing games together (60).

Implications for Future Research

Our recommendations for future research are to undertake research with a sample that is more representative of the total population in Aotearoa New Zealand. Māori made up 10.5% of respondents, and Pacific people made up only 2.7% (**Table 4**). These proportions are low compared to the demographic population of Aotearoa New Zealand, where 16.7% of the population is Māori, and 8.3% of the population is Pacific (73). Our responsibility in Aotearoa New Zealand is to uphold Te Tiriti O Waitaingi and ensure that Māori perspectives are represented in all research areas, and that evidence-based policies reflect the needs of Māori to minimize inequities between Māori and non-Māori (74). Future research on eating behaviors during lockdown that utilizes a Kaupapa Māori approach is needed. Having a comprehensive understanding of the impact of the pandemic on all people in Aotearoa New Zealand is imperative to inform more equitable policy decisions.

This study investigated the extent to which mealtime behaviors changed during lockdown but could not thoroughly investigate why these behaviors changed. The literature on mealtime planning in low-income families is lacking. Family dynamics and food insecurity may potentially have an impact and more research in that area is needed. The scope of a quantitative survey study design meant that there was minimal context available regarding the participant's experiences of lockdown or why they felt their behaviors changed. A qualitative research approach would address this gap and could be achieved through interviews and/or analyzing social media content. The Zoom focus group method used by Hammons and Robart (40) and described in detail by Pocock et al. (65) would be a good option for conducting qualitative research in the event of another lockdown. Qualitative studies to explore people's experiences and perceptions of mealtime behaviors and stress during lockdown would be particularly beneficial to understand more about why our findings revealed both an increase in stress and an increase in beneficial mealtime behaviors. It would also be interesting to see if these behaviors adopted during the first COVID-19 lockdown were maintained once lockdown restrictions eased, or if old habits and routines were reinstated.

Increasing the availability of funding for qualitative research would enable researchers and policymakers to understand the experiences of Aotearoa New Zealanders in lockdown more thoroughly.

CONCLUSION

This study investigated changes in mealtime behaviors during the first 2020 COVID-19 lockdown in Aotearoa, New Zealand. Data from the COVID Kai Survey indicated that cooking meals at home, eating meals at the dinner table, and considering mealtimes to be an important part of the day, all increased during lockdown. Eating out or getting takeaways, decreased over this period. Across most household types, people who were psychologically distressed during lockdown were more likely to consider mealtimes as an important part of the day. Those who reported psychological distress and resided in households with children were more likely to eat dinner at the dinner table. Single-parent households reported the highest rates of financial hardship, and psychological distress. This study advances current understanding of mealtime behaviors during crises and adds to the growing body of literature regarding the everyday impacts of COVID-19. Further research is required to fully understand the experience of psychological distress on mealtime behaviors with a representative sample of people residing in Aotearoa New Zealand. Qualitative studies that expand on the reasons behind behavior change are needed.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because we did not receive ethical approval to share raw, anonymized data with others. Requests to access the datasets should be directed to corresponding author.

ETHICS STATEMENT

The Corona Cooking Survey was granted ethical approval by the Ethics Advisory Committee on Social and Human Science at the University of Antwerp on April 16th 2020 (ref: SHW_20_46). The Aotearoa New Zealand arm of the study was granted ethical approval by the University of Auckland Human Respondents Ethics Committee on 24 April 2020 for 3 years (ref: 024607). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

VE, LH, RR, LTM, LT, PD, IC, CD, and SG: conceptualization, data curation, investigation, and methodology. LH, VE, and SG: formal analysis and writing—original draft. VE, RR, LTM, LT, PD, IC, CD, and SG: funding acquisition. RR, LTM, LT, PD, IC, and CD: writing—review and editing. All authors have read and agreed to the published version of the manuscript.

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European household spending and socio-economic impacts on food behavior during the first wave of COVID-19

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This paper provides a European-level analysis using a large-scale survey of 13 countries to examine the power of relevant economic and socio-demographic characteristics to account for changes in food consumption and purchasing behavior during COVID-19. This was done by focusing on a two-level analysis of subject-related predictors highlighted in many existing country-level studies to test the generality of their significance. The Level 1 predictors relate to the individual households participating in the survey consisting of household composition, education, and location, as well as three types of perceived COVID-19 risks of infection, severity, and anxiety. Level 2 relates to the national level, and especially to the financial situation measured by the mean national Actual Individual Consumption (AIC) per capita in PPP, of the countries, in which the households reside. In terms of changes in food consumption, results show that household composition, education, and the household's perceived risk of both being infected by COVID-19 and being severely infected are significant predictors, although there are some differences between the two levels. Some possible explanations are as follows: putting food into one's body in the context of the pandemic is related to a household's financial situation, its composition, especially the presence or absence of children and older people, and its educational attainment, and through all these aforementioned to the perception of COVID-19 infection and its severity risks. Changes in food purchasing react significantly to the same predictors, but additionally, to all other predictors at both household and AIC levels. The household's location and perceived COVID-19 anxiety risks are thus also significant. Food purchasing depends much more on factors operating both at the individual household level and the AIC level together; for example, households' access to food is affected by both national and local lockdown restrictions that vary according to the location of the household.

KEYWORDS

food consumption, food purchasing, COVID-19, financial status, household composition, behavioral change

Introduction

Introduction and structure of the paper

The first wave of the COVID-19 pandemic that started in March 2020 had widespread and severe impacts in terms of lockdowns, closures, and restrictions on both economic and social life across the whole of Europe. Even so, there were important differences in detail between countries and regions in terms of when and how these measures were applied by both national and regional authorities (1, 2). These policy and regulatory differences were reflected in variations in the access to, and consumption of, food by households and their behavioral responses. This was further complicated by the continent's varied food systems, food cultures, political systems, economic conditions, socio-economic and cultural characteristics, agricultural practices, and climate zones. Hence, many important differences are observed between countries, as reflected in the "Literature review" section.

However, also as apparent from the literature review, there are many similarities between countries when viewed on a larger European scale, two of the most important of which are in focus in this paper drawing on a consumer behavior survey of 13 countries: Czechia, Denmark, France, Germany, Greece, Hungary, Ireland, Israel, Italy, the Netherlands, Serbia, Slovenia, and the United Kingdom. First, an assessment of the general financial situation of the population using a monetary measure of consumption based on national Actual Individual Consumption (AIC) data before the pandemic as a predictor of food security or vulnerability during the pandemic. Second, the household composition and, particularly, the presence, or otherwise, of children. The significance of these two proposed predictors is tested in this paper in relation both to food purchasing and food consumption, while not ignoring other potential predictors, which likely contribute to the food behavioral changes seen.

The paper is structured into four main sections. First, this Introduction lays out the overall context and purpose of the paper, provides a literature review relevant to this purpose, and states the paper's main aims. The section on "Materials and methods" describes the sample used, how data collection takes place and the limitations of this, explains how the data are analyzed, and articulates the conceptual framework underpinning how these materials and methods are deployed. The "Results" section looks, first, at the descriptive statistics of four country groups based on their AIC data in relation to COVID-19 restrictions, risk perceptions, and six national cultural dimensions. Second, it undertakes a modeling analysis of changes in food consumption and purchasing in relation to the AIC groups and three categories of household composition. Third, the "Results" section also examines the model estimated changes in food consumption and purchasing in relation to the AIC groups and the three categories of household composition. Finally, the "Discussion" section draws out and discusses some overall conclusions about the importance of different types of predictors and possible explanations for the results seen.

Literature review

A large amount of literature has already examined the impact of COVID-19 on food systems and consumer behavior. In a survey of households in Denmark, Germany, and Slovenia, Janssen et al. (3) found that between 15 and 42% changed their food consumption patterns during the first wave of COVID-19 and that this was related to the closure of physical places to eat outside the home, reduced shopping frequency, individuals' perceived risk of COVID-19, income losses due to the pandemic, and socio-demographic factors including household composition. In a German study, Profeta et al. (4) showed that COVID-19 had a significant impact on consumers' eating habits that generally led to negative health consequences, especially amongst economically vulnerable groups, including households that lost income during the pandemic, and those with children. The purchase of ready meals and canned food increased, including the consumption of alcohol and confectionery, at the same time as there was a decrease in the purchase of high-quality and more expensive food like vegetables and fruits. Similar patterns are seen in the state of Vermont in the United States where the utilization of food banks was more common among food-insecure households and households with children. Many food-insecure respondents were also significantly more likely to report consuming fewer fruit and vegetables during the pandemic (5). Similarly, Millard et al. (2) showed that households that lost income during the pandemic were much more likely to grow their food and to obtain free food in food banks. Capodistrias et al. (6) outlined how in 2020, compared to 2019, European food banks redistributed a significantly higher amount of food despite numerous social restrictions and other challenges associated with the pandemic.

A study in Denmark found that a substantial proportion of respondents ($\geq$ 28%) reported eating more, snacking more, exercising less, and gaining weight during the lockdown (7). Results could be linked to the amount of time spent at home (e.g., a higher cooking frequency) and a higher degree of emotional eating during the lockdown (e.g., higher consumption of pastries and alcohol). Two studies in Italy showed, first, that during the first phase of COVID-19 people increased their interest in and appreciation of food, as well as of environmental, human, and animal welfare issues (8). The second Italian study showed, that although the amount of food consumed during the pandemic increased, food waste declined as people moved to more non-perishable food and away from fresh food products (9).

A meta-analysis of COVID-19-induced changes in food habits in Italy, France, Spain, Portugal, and Poland indicated the generally negative effect of quarantine on eating habits and physical activity with an increase in food consumption and reductions in physical activity, as well as consequential weight gain (10). An analysis of consumer spending data largely focused on Australian and American markets, charted the potential increase of negative psychological effects during the pandemic, like panic buying, herd mentality, and changing discretionary spending (11). In a survey of 54 countries from January to April 2020, Taylor (12) found that pandemics often give rise to the panic buying of groceries and other supplies, especially when people are told to go into self-isolation. This can spread *via* social media showing images and videos of people panicking and emptying shelves in shops, leading to a snowball effect where anxiety and fear of scarcity create real but short-term scarcity. In an Italian survey, Di Renzo et al. (13) showed that physical distancing and self-isolation strongly impact the lives of the citizens by affecting their eating habits and everyday behavior. The two major impacts include staying at home (leading to digital education, smart working, limited outdoor activity, and in-gym physical activity) and stockpiling food due to the restrictions on grocery shopping. There are also generational effects, as demonstrated by Eger et al. (14) in Czechia during the second wave of COVID-19. Baby Boomers (born between 1946 and 1964 and currently between 58 and 76 years old), Generation X (born 1965-1979/80 and currently 42-57), and Generation Y (born 1981-1994/6 and currently 26-41) each changed their shopping behavior in distinctive ways related to their specific fears. During the crisis, all consumer types tended to focus on their most basic needs, so for the Baby Boomer generation, fears for health played an important role, whereas, for both Generations X and Y, job loss fears were the most important. All three generations had similar fears about their general economic situation.

Valaskova et al. (15) show that the pandemic has affected every aspect of consumer behavior: their expenses, investments, and financial reserves, as well as their financial and social wellbeing. A sample of 425 Slovak respondents was analyzed to reveal the most important factors impacting consumers' financial situations, as well as effects on the maintenance of new shopping habits established during the pandemic period. The results revealed that consumers' income, age, and sector of occupation play important roles in the context of new shopping patterns. Similar findings are noted by Jay et al. (16) in the United States, where a strong negative relationship was found between neighborhood income and physical movement. Individuals in high-income neighborhoods increased their days at home substantially more than did the individuals in low-income neighborhoods. Residents of low-income neighborhoods were more likely to work outside the home and have generally faced many more barriers to physical distancing.

Based on a sample of 456 Italian consumers, Russo et al. (17) investigated both the short-term and long-term effects on consumers' dietary decisions during the first wave of the pandemic emergency. They looked at changes in food purchases, respondents' mood during the lockdown, conspiracist beliefs, exposure to the virus, and planned food purchasing behavior after the lockdown. Two opposite approaches to changes in food purchasing decisions were identified: an impulsive approach and a reflective approach, with the former demonstrating a higher probability of changing food purchases but a lower probability to keep these changes over the longer term. Results suggest that COVID-19 psychological pressure was associated with an impulsive approach to buying food. Consequently, food-purchasing behavior is expected to revert to pre-COVID-19 habits when the emergency is over. In contrast, Millard et al. (2) analyzing data from 12 European countries showed that, during the pandemic, income-loss-households are more likely than other households to state that some of the positive changes they have made and were, perhaps, forced to make, during COVID-19 are more likely to continue post-pandemic. These include significant increases in shopping with local producers and in more local shops, growing their food, and using a wider range of food dishes and recipes. However, it is unclear whether the reason for this expectation by income-loss households is that they can see the benefits of such changes which in some, but by no means all, cases are already practiced by no-income-loss households, or because they expect their relatively precarious situation will persist regardless of the state of the pandemic.

It has long been noted that boredom and stress can lead to over-eating, especially "comfort food" with a high sugar content that increases serotonin intake leading to a positive effect on mood (18). It is now clear that a further acceleration of these behaviors has been driven by COVID-19 alongside a reduction in fresh fruit and vegetable consumption and, as noted above, these pandemic-induced trends are seen especially in more financially vulnerable households given their more tenuous links to the labor market and greater likelihood of infection, and thus higher potential stress levels (3, 19). Indeed, Millard et al. (2) revealed the high importance of whether households lost income during the pandemic and that this is a good surrogate for individual household income. Despite the fact that all categories of the household during COVID-19 increased both the amount of food eaten and the amount of money spent on food, income-loss households were more likely to do this despite their financial fragility even before the pandemic, which then made their situation worse. Income-loss households nearly always experienced food behavior changes arising from COVID-19 much more than no-income-loss households, probably because their financial and social situations are more precarious, so they are more sensitive to external shocks and are likely to react more strongly under stress. The precariousness of income-loss-households is also related to the fact that they are overrepresented in regions with the lowest PPP/inhabitant, have

a lower mean age, and are more likely to be families with children, which together imply both lower earning potential and that finances need to be stretched further.

Aims of this paper

The above literature review starkly demonstrates the often dramatic changes in food-related behaviors during COVID-19 and that economically and socially vulnerable consumers seem to be affected by the pandemic much more than others. Indeed, there is very strong evidence that households already experiencing some financial vulnerability were pushed to even greater precariousness during the pandemic, thereby, further exacerbating food vulnerability, and related inequalities. The literature review also underlines the importance of household composition in influencing COVID-19-induced food behavior changes.

However, given that much of the existing literature focuses mainly on single countries or small groups of countries, this paper's relatively large-scale survey of 13 countries aims to analyze relevant economic and socio-demographic characteristics at the European level by focusing on the two main predictors of households' financial situation and household composition. Thus, the 13 countries are grouped according to their mean AIC per capita in PPP, as detailed in **Table 1**. AIC is potentially a relevant perspective on household financial resilience, or lack of such, as it relates directly to the size of their disposable income, as well as influencing the propensity for households to save (20). According to Eurostat (21), food in EU households in 2019 "represents 13% of total consumption expenditure and ranks as the third-largest category of household expenditure after "housing, water, electricity, gas, and other fuels, which accounted for 23.5% of household expenditure, and "transport" (13.1%)." As noted in the literature review, there is also strong evidence that expenditure on food increased during the pandemic. This conclusion is backed by the latest Eurostat data showing that since 2019, expenditure on food increased by 3.2%, communications by 2.4%, and household consumption of energy and water by 0.3%, while all other expenditures decreased, including eating out by –37.8% (22). Most people were stuck at home during lockdowns, so had more time to devote to food and were able to divert some expenditure from transport and entertainment to food, although the frequency of food purchasing decreased due to shopping restrictions.

The aim of the paper is thus to examine the extent to which the variance across the two main food-related behaviors of consumption and purchasing within the whole sample of 13 countries can be explained at two levels: Level 1 of individual survey households, and Level 2 of AIC (a monetary measure of consumption). Various combinations within and between these two levels are examined. The paper thereby aims to fill an important gap in the literature by extending our understanding of how a sudden shock impacts these behaviors.

Materials and methods

Sample description and data collection

The evidence base consists of data from a common online questionnaire containing 34 questions that were accessible *via* a dedicated website[1] and are now available as part of the **Supplementary Material**. It was designed to capture the changes in respondents' behavior in relation to food purchasing, preparation, and consumption, as well as experiences of COVID-19-related illness, regulations, and closures. Ancillary information was also collected on household socio-economic characteristics, including households' income changes from before to during the pandemic. The questionnaire was translated into national languages by local researchers from the 13 countries, providing a good representation of Europe's varied food systems, food cultures, political systems, economic conditions, socio-demographic characteristics, agricultural practices, and climate zones.

The sampling of respondents combined two methods. First, representative quota samples of respondents based on gender, age, education, and regional distribution (data collection by market research agencies). Second, convenience sampling was deployed, by which respondents were contacted largely *via* social media, although local researchers in these countries attempted to reach out to all main population groups in all parts of the country. We recognize the potential limitations of this dual strategy made necessary because our network of researchers from many countries needed to be established rapidly as the first wave struck, so not all of them were able to quickly ensure enough funding for representative sampling and data collection by market research agencies. In some countries, such agencies were hired but funding was restricted so the quota sampling and data collection were accompanied by some convenience sampling of respondents to boost the sample. However, to minimize any bias we have weighted each country's sample based on their 2020 population, as indicated in **Table 1**. In addition, this research study is based on relatively large sample sizes where local researchers endeavored to include as many different population cohorts as possible even when convenience sampling was implemented. Moreover, the questionnaire was entirely consistent across all countries, translated into local languages by local experts, and the analysis does not take place at the individual country level.

The questionnaire responses that were considered invalid, and thus excluded, were those where respondents took less than

1 https://www.food-COVID-19.org/

5 min to answer or where they had responded incorrectly to attention-check questions in different parts of the questionnaire. These procedures resulted in responses from at least 100 households in each country yielding 8,009 responses in total (see Table 1 for an overview). Data were collected during the first wave from March to July 2020 and then merged into a large dataset of respondents from all 13 countries. Table 1 describes the sampling method, crude, and weighted data per country, as well as how countries were clustered into four groups based upon their populations' AIC as measured by Eurostat-OECD in terms of Purchasing Power Parity (PPP).

To determine changes in food consumption, participants were asked to report how often they consumed 11 types of fresh food, non-fresh food, convenience food and snack food during and before the pandemic. Food purchasing was analyzed based on the four types of fresh fruit and vegetables, fresh meat and meat products (including fish), other fresh products (bread, milk, cheese, etc.), and other non-fresh food (frozen, canned, pre-cooked, drinks, etc.). The food consumption and purchasing frequency questionnaire contained a six-point scale, each of which was proportionately weighted, comprising the following: less than once a fortnight; between once a week and once a fortnight; once a week; 2–3 times a week; 4–6 times a week; and daily. Participants were also asked whether they had experienced certain changes due to COVID-19, including changes in household income and the closure of their physical workplace. Further questions covered the extent to which households had been afflicted with COVID-19, and their own perceived risk of the disease in terms of infection, severity, and anxiety as shown in Table 2, each with a five-point answer scale from very low to very high. Finally, questionnaire respondents provided data on the demographic details of their households and themselves (The full questionnaire is available in the Supplementary Material).

Table 3 provides data on the main range of socio-economic and demographic variables of the sample across the four AIC groups.

In Table 3, there is a greater likelihood for households in the two lower AIC groups to reside in rural locations compared to the two higher AIC groups, which tend to be more urban. The lower AIC groups are also more likely to have younger households than the higher AIC groups, and this is especially marked in the Very Low group. The household composition also reflects these two locational and age observations. The lower AIC groups have fewer single-person households than the higher groups, indicating the higher frequency of older

TABLE 1 Description of the sample and population-weighted adjustments.

Country sample	Sampling method	Sample data *N* (%)	Weighted data *N* (%)[a]	AIC per head & PPPs[b]	Allocation to AIC group[c]
Denmark	Quota	1,281 (16.1)	131 (1.6)	34,601	Very high
Germany	Quota	1,020 (12.8)	1,870 (23.4)	36,509	
Netherlands	Convenience	122 (1.5)	389 (4.9)	34,103	
United Kingdom	Convenience	314 (3.9)	1,526 (19.1)	33,866	High
Ireland	Convenience	595 (7.4)	111 (1.4)	28,435	
France	Quota	644 (8.0)	1,489 (18.6)	29,545	
Italy	Convenience	538 (6.7)	1,340 (16.7)	25,935	Low
Israel	Quota	641 (7.7)	197 (2.5)	25,935	
Czechia	Quota and convenience	805 (10.2)	241 (3.0)	25,377	
Slovenia	Quota	683 (8.5)	47 (0.6)	24,608	Very low
Hungary	Convenience	720 (9.0)	218 (2.7)	20,075	
Greece	Convenience	539 (6.7)	252 (3.1)	23,129	
Serbia	Convenience	107 (1.3)	197 (2.5)	15,132	
Total		8,009 (100)	8,009 (100)		

AIC group[c]	Sample data *N* (%)	Weighted data *N* (%)[a]	Mean (*SD*) AIC per head and PPPs[b]
Very low	2049 (25.6)	715 (8.9)	20,736 (4186)
Low	1984 (24.8)	1,778 (22.2)	25,749 (322)
High	1553 (19.5)	3,126 (39.0)	30,615 (2869)
Very high	2423 (30.1)	2,381 (29.9)	35,071 (1270)

[a]Weighted according to each country's 2020 population: https://data.oecd.org/pop/population.htm. [b]AIC is Actual Individual Consumption per head at current prices ($) and purchasing power parity (PPP), 2019: https://www.oecd-ilibrary.org/economics/actual-individual-consumption-price-indices_26ff7815-en (26). [c]Quartile segmentation based on country Actual Individual Consumption per capita and PPP ($), 2019.

TABLE 2 COVID-19-related risk perceptions and impacts per the AIC group: weighted data analysis.

Variable	Level	Very low AIC *N* (%)	Low AIC *N* (%)	High AIC *N* (%)	Very high AIC *N* (%)
COVID risk infection	Low	191 (27.0)	697 (39.2)	1,370 (43.8)	1,051 (43.9)
	Medium	288 (40.7)	799 (44.9)	1,245 (39.8)	1,054 (44.1)
	High	229 (32.3)	283 (15.9)	511 (16.3)	286 (12.0)
COVID risk severity	Low	193 (27.2)	589 (33.1)	1,111 (35.5)	984 (41.2)
	Medium	228 (32.1)	578 (32.5)	1,040 (33.3)	909 (38.0)
	High	289 (40.7)	611 (34.4)	976 (31.2)	498 (20.8)
COVID risk anxiety	Low	229 (32.3)	443 (24.9)	1,206 (38.6)	990 (41.4)
	Medium	252 (35.6)	680 (38.2)	1,148 (36.7)	858 (35.9)
	High	228 (32.1)	656 (36.9)	772 (24.7)	544 (22.7)
COVID infection	Yes	55 (7.8)	89 (5.0)	193 (6.2)	87 (3.6)
COVID isolation	Yes	82 (11.5)	118 (6.6)	231 (7.4)	89 (3.7)
COVID hospitalization	Yes	12 (2.1)	7 (0.4)	17 (0.5)	6 (0.3)

TABLE 3 Description of the AIC groups socio-economic and demographic: weighted data analysis.

Variable	Category	Very low *N* (%)	Low *N* (%)	High *N* (%)	Very high *N* (%)
Total *N* (%)		715 (100)	1,778 (100)	3,126 (100)	2,381 (100)
Household location[†]	Urban	267 (39.2)	770 (46.9)	1,247 (42.6)	1,188 (53.6)
	Intermediate	252 (37.0)	516 (31.5)	1,296 (44.3)	755 (34.1)
	Rural	162 (23.8)	355 (21.6)	383 (13.1)	272 (12.3)
Mean age (*SD*)	Mean age	31.8 (13.6)	44.7 (13.3)	50.0 (15.1)	49.3 (15.7)
Age groups	18–35	303 (68.4)	454 (25.6)	608 (19.5)	530 (22.2)
	36–49	98 (22.1)	648 (36.5)	870 (27.9)	576 (24.1)
	50–65	35 (7.9)	560 (31.6)	1,099 (35.2)	877 (36.8)
	66 and older	7 (1.6)	112 (6.3)	543 (17.4)	403 (16.9)
Gender	Female	363 (65.4)	1,091 (61.6)	2,105 (67.9)	1,347 (56.6)
	Male	192 (34.6)	680 (38.4)	993 (32.1)	1,031 (43.4)
Education	Lower secondary or equivalent	25 (3.5)	2 (0.1)	128 (4.1)	227 (9.5)
	Upper secondary of equivalent	298 (42.0)	503 (32.8)	714 (22.9)	1,244 (52.0)
	University degree or equivalent	386 (54.5)	1,029 (67.1)	2,277 (73.0)	921 (38.5)
Income change	Income-loss	137 (84.6)	576 (38.9)	27 (3.3)	1,466 (75.5)
	No-income-loss	25 (15.4)	904 (61.1)	787 (96.7)	476 (24.5)
Household composition	Household with children 0–19	86 (15.9)	649 (38.0)	947 (30.8)	564 (23.9)
	Single-person household	84 (15.5)	329 (19.2)	745 (24.2)	717 (30.4)
	Households 2 + adults, no children	372 (68.6)	732 (42.8)	1,384 (45.0)	1,078 (45.7)

[†]This regional typology is taken directly from the Eurostat categorizations across the whole of Europe where further details are given: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Archive:Regional_typologies_overview#Urban-rural_typology_including_remoteness. The last date this document was edited by Eurostat was 3-11-20 and is now marked as archived, but NUTS-3 categorizations remain available on https://circabc.europa.eu/d/d/workspace/SpacesStore/ea154527-d900-431f-b5a8-97fbea6e4b08/regtyp.xls) and can be used to access all Eurostat's regional data: https://ec.europa.eu/eurostat/web/regions/data/database. (All accessed November 20, 2021).

persons living alone, especially in urban areas. Furthermore, the two lower AIC groups taken together are more likely to have experienced income loss during the pandemic, which is probably related to the fact that the greater proportions of younger people in these countries tend to be younger couples without children and to be more vulnerable to an economic shock like COVID-19. Related trends from lower to higher AIC are, however, not seen in the education and gender data, probably because these both record the status of the individual respondent rather than the respondent's total household, which the other variables represent. As in most questionnaires of this type, respondents answering the questionnaire are more likely to be female with a higher than average education. Thus, these two variables in the sample data do not vary in any consistent manner from the Very Low to the Very High AIC groups, so are unlikely to significantly skew the results across the groups.

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Conceptual framework

Figure 1 sketches the overall conceptual framework indicating how this paper examines food behavior change during COVID-19 in the context of two sets of predictors selected based on the existing literature and the authors' investigation of the dataset available, as described above. First, there is a set of "direct predictors" at Level 1, so-called as the variables examined consist of data at the individual household level provided by the same respondents reporting their food-related behavioral changes. The main direct predictor of interest is household composition highlighted in capital letters and bold font in Figure 1, while the other direct predictors named are also examined. Second, we examine a set of "indirect predictors" at Level 2, so-called because they are not part of the questionnaire household survey data but are contextual variables collected from reliable sources as explained above. In this case, the main indirect predictor of interest is the national AIC variable, also marked in capital letters and bold font in Figure 1.

Even though AIC is generalized at the national level, the results reported in the "Results" section show it to be the most consistently significant predictor examined. This result was surprising but should not be ignored simply because it is difficult to explain the fact that such a national indicator seems to influence most households in the survey. Reference to Tables 2–5 shows it is strongly related to most socio-economic, demographic, pandemic restrictions, and cultural dimensions, thus, providing an important part of the national setting within which the questionnaire respondents reside and are undoubtedly influenced. We saw from the literature review that income and financial security, in general, were some of the most important predictors of changing food behavior during COVID-19. On this basis, when designing the questionnaire, many partners were keen to ask respondents about their income, as well as their food consumption and purchasing in monetary terms. However, in operational terms, severe constraints arose related to the available time and resources and the level of respondent cooperation required. Thus, it was deemed too challenging to assume that respondents would be able to answer an income question accurately and quickly using the same income and monetary definitions to enable legitimate comparisons across the whole of Europe. Hence, national AIC is used in this paper as a relevant monetary measure of consumption. It is even more powerful than the direct Level 1 predictors, although many of these, including household composition, are also powerful. Another possible reason for the power of national AIC as a predictor is because individual household consumption and income have a strong tendency to be more or less contingent on national economic conditions and policies [e.g., see (21, 22)], especially when we examine large samples of households together, as in this paper. One aim of the paper has been to test this assumption, and the results below do show that there is much credence in doing so.

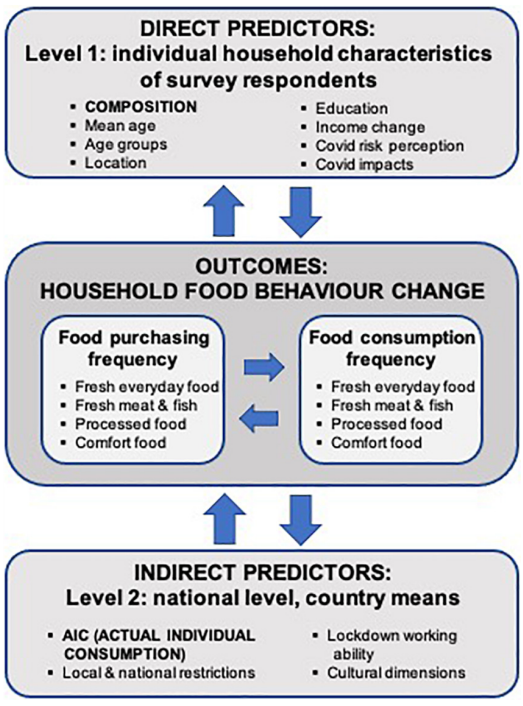

FIGURE 1
Conceptual framework of both direct and indirect predictors of households' food change during COVID-19.

Data analysis

Statistical analyses and data management were performed using IBM SPSS Statistics for Windows, version 27 (IBM Corp., Armonk, N.Y., United States). The main predictors (independent variables) and the main outcomes (dependent variables) examined are listed in Figure 1 (see below for further explanations and necessary definitions). Most of the independent variables were direct measures from the questionnaire or were modified by reducing the number of levels to one feasible for analysis, while AIC was created based on the quartile segmentation of each country's AIC and PPPs per head at current prices ($) (see Table 1). All socio-demographic and household-related responses are reported as counts and frequencies, while lockdown working ability data (see Table 4) and cultural dimension data (see Table 5) are with means and standard deviations (*SD*). The change in food consumption and purchasing were calculated separately for each observed food category as the difference between frequency measured on a six-point scale during and before COVID-19. The determined change for different food consumption and purchasing types was further used in the within-subject analysis under different between-subject conditions.

To determine the individual household and the AIC level effects, a mixed model repeated measure analysis was employed following the approach presented in the study by Diener and Lucas (23) was employed. For the fixed factors used in both level analyses, categorical variables' education, household composition, household location, and the three COVID-19-related risk variables were used. Multivariate analysis of variance (MANOVA) was also used to determine the effect of predictors on dependent variables. A pairwise comparison analysis between the levels of independent predictors using Sidak and the LSD (least significant difference) adjustment method was performed and the *p*-values with a false detection rate below 0.05 were considered.

Results

In this section, the main results are described and commented on in line with the aims of the paper as outlined in section "Aims of this paper." The overall focus is on the two main food-related behavioral changes of household food purchasing and food consumption, demonstrated in the literature review, and elsewhere, to have been considerably and significantly impacted by COVID-19. Several subject-related predictors are deployed to describe these impacts on both the individual and the AIC levels as also discussed in the literature review, i.e., variable categories represented by education, household composition, residence category, and COVID-19 risk-related variables. As mentioned above, focusing on these specific variables is undertaken to fill an important research gap.

This "Results" section is organized in the following way. First, COVID-19 restrictions, risk perception and cultural profiling across the four AIC groups are described. Next the results of the mixed model analysis are presented, focusing on mixing both the individual household level and the AIC level effects. Finally, a detailed analysis of the changes in the marginal means of food consumption and purchasing during COVID-19, in relation to the AIC groups and household composition categories, is presented.

TABLE 4 Description of the AIC groups based on local and national COVID-19 restrictions' impact on households and lockdown working ability: weighted data analysis.

Variable	Level	Very low AIC *N* (%)	Low AIC *N* (%)	High AIC *N* (%)	Very high AIC *N* (%)
Total *N* (%)		715 (100)	1,778 (100)	3,126 (100)	2,381 (100)
1) Travel and movement restrictions	No impact	57 (24.9)	238 (16.2)	507 (17.8)	1,086 (48.0)
	Small impact	65 (28.4)	517 (35.2)	1,286 (45.0)	1,197 (31.1)
	Large impact	107 (46.7)	715 (48.6)	1,062 (37.2)	837 (20.9)
2) Closure or restrictions on public transport	No impact	103 (46.0)	562 (50.3)	1,250 (54.2)	1,282 (61.2)
	Small impact	41 (18.9)	351 (31.5)	637 (27.6)	630 (29.8)
	Large impact	78 (35.1)	203 (18.2)	419 (18.2)	208 (9.0)
3) Closure of restaurants, cafés, and canteens	No impact	57 (32.6)	207 (14.3)	456 (16.4)	576 (24.5)
	Small impact	83 (47.4)	746 (51.3)	1,377 (49.5)	1,613 (49.9)
	Large impact	35 (20.0)	499 (34.4)	949 (34.1)	955 (25.6)
4) Closure of you (physical) workplace	No impact	49 (35.5)	128 (14.3)	324 (17.3)	1,555 (33.7)
	Small impact	20 (14.5)	225 (25.1)	450 (24.0)	391 (30.4)
	Large impact	69 (50.0)	544 (60.6)	1,101 (58.7)	722 (35.9)
5) Closure of education and care institutions	No impact	117 (53.7)	567 (40.1)	1,144 (49.1)	1,555 (64.2)
	Small impact	26 (11.9)	231 (16.3)	418 (18.0)	391 (12.4)
	Large impact	75 (34.4)	616 (43.6)	765 (32.9)	722 (23.4)
6) Closure of other public places	No impact	87 (41.8)	393 (27.9)	853 (33.0)	1,063 (42.4)
	Small impact	55 (26.5)	534 (37.9)	1,047 (40.4)	1,169 (38.6)
	Large impact	66 (31.7)	481 (34.2)	688 (26.6)	612 (19.0)
7) Restrictions on people in one place	No impact	63 (29.2)	286 (19.7)	581 (21.8)	810 (31.7)
	Small impact	77 (35.6)	528 (36.3)	1,224 (45.7)	1,299 (40.0)
	Large impact	76 (35.2)	641 (44.0)	869 (32.6)	920 (28.3)
8) Lockdown working ability	Mean score (*SD*)	0.14 (0.12)	0.40 (1.1)	0.52 (2.0)	0.57 (0.60)

Lockdown working ability is measured from 0.0 as the minimum to 1.0 as the maximum (See text for explanation).

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TABLE 5 Description of the AIC groups based on national cultural dimensions: weighted data analysis.

Variable	Very low AIC Mean (*SD*)	Low AIC Mean (*SD*)	High AIC Mean (*SD*)	Very high AIC Mean (*SD*)
Power distance	74.7 (113.5)	47.0 (66.3)	45.2 (80.7)	36.9 (66.0)
Individualism	32.3 (36.0)	72.1 (134.1)	82.9 (276.2)	75.2 (70.4)
Masculinity	49.4 (67.7)	66.5 (88.1)	58.8 (217.9)	32.6 (59.1)
Uncertainty avoidance	89.9 (113.1)	75.5 (140.9)	51.0 (142.3)	56.7 (58.0)
Long-term orientation	50.1 (44.5)	59.6 (149.5)	54.1 (138.6)	72.1 (75.6)
Indulgence	31.4 (50.0)	26.9 (73.5)	62.3 (263.9)	58.0 (52.7)

The mean scores are of the scores for each country in a given AIC group. Full explanations for each of the six national cultural dimensions, and how these are derived, are provided in Hofstede Insights (24).

Descriptive statistics of actual individual consumption groups in relationship to COVID-19 restrictions, risk perception, and cultural profiling

Table 4 describes the variability of pandemic-induced restrictions and closures across the four AIC groups in rows 1–7. These are as reported, and thus experienced, by household respondents in the survey themselves, which arguably is more likely to influence their behavior than official restrictions. Row 8 provides national data on lockdown working ability during the first wave of COVID-19, obtained from Palomino et al. (19), defined as the capacity of individuals to work under a lockdown which considers their teleworking capacity. The spread of COVID-19 had direct asymmetric effects on the labor market: in principle, only the jobs that can be done from home ("teleworkable") are unimpeded by the lockdown. Some occupations like health services and food sales are considered essential, so workers are not affected by their capacity to work from home. Meanwhile, certain economic activities like hospitality are closed under the lockdown and working is not at all possible.

Table 4 shows a number of significant trends from the Very Low to the Very High group. Generally, the impact of transport restrictions decreases from the low AIC end to the high AIC end. In terms of closures, the pattern is similar but also more nuanced so that typically the Low group, sometimes together with the High group, sees greater impact than the Very Low group, while the Very High group always experiences least impact except in relation to the closure of restaurants, cafés, and canteens. The possible explanation for the latter is that the Very High group also sees the lowest closure of workplaces and many canteens are part of these workplaces that close less often. In this group, the higher preponderance of white-collar offices as compared to more blue-collar establishments perhaps reflects the nature of the work here as being more easily adaptable to social distancing and other COVID-19 rules. In contrast, the other closures tend to be due to government regulations applied unilaterally rather than on a workplace basis. Overall, it can be seen that the Very High and High groups were both affected less by, and more able to adapt to, pandemic-related restrictions and closures. The existence of this general trend is also shown by the lockdown working ability scores that rise continuously from Very Low to Very High, demonstrating the increased availability and quality of teleworking infrastructures and how conducive to teleworking their occupational profiles are seen to be.

In Table 2, the three types of risk perception, i.e., infection, severity, and anxiety, the perception level generally decreases significantly along the AIC spectrum from Very Low to Very High and is most clearly seen in terms of severity where there is an unbroken progression. Very similar downward trends come from actual household infection, isolation, and hospitalization, where the High AIC group is only a slight outlier to this significant trend.

Table 5 presents an interesting and, as far as we are aware, unique examination of national culture in relation to differences along the AIC dimension, and arguably thereby also in relation to food behavior and changes during COVID-19 as examined in this paper. We have used the Hofstede Insights (24) tool that assigns scores out of 100 for each country across six dimensions of national culture as shown in Table 5.

The national cultural differences across the four AIC groups in Table 5 present some very clear significant trends. Power distance (measuring how far away individuals in a given country feel from the centers of power) shows a marked decline along the Very Low to Very High spectrum. In other words, people toward the higher AIC end tend to feel much more empowered as individuals than their counterparts in the lower AIC countries. A similar trend is seen in terms of uncertainty avoidance, i.e., individuals at the lower AIC end are more likely to attempt to avoid uncertainty in their behavior. The opposite trend of an increasing cultural trait from the low to the high AIC countries is seen in relation to individualism, long-term orientation, and indulgence. The sixth cultural dimension, masculinity, although statistically significant, has a much lower correlation coefficient than the other five and does not appear to vary in a regular manner along the AIC spectrum, although it might be interesting to note that the Very High AIC group has the lowest masculinity score.

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TABLE 6 Repeated measures mixed-model analysis with individual household and AIC levels of regional, household composition, educational, and COVID-19 risk perception effects on change in consumption and purchasing of food due to effects of the COVID-19 pandemic.

Model	Individual (Level 1)	AIC (Level 2)	df*	*F*	Sig.
1. Food consumption					
Intercept			1;65539	0.70	0.404
	Household composition		2;65539	1.40	0.246
		Household composition	6;65539	3.30	0.003
	Education		2;65539	4.54	0.011
		Education	6;65539	1.97	0.066
	Household location		2;65539	0.18	0.835
		Household location	6;65539	1.24	0.283
	Risk for infection		2;65539	8.0	<0.001
		Risk for infection	6;65539	5.98	<0.001
	Risk for severity		2;65539	11.2	<0.001
		Risk for severity	6;65539	0.48	0.835
	Risk for anxiety		2;65539	0.40	0.671
		Risk for anxiety	6;65539	0.74	0.621
2. Food purchasing					
Intercept			1;24031	108.5	<0.001
	Household composition		2;24031	3.59	0.028
		Household composition	6;24031	20.9	<0.001
	Education		2;24031	10.54	0.01
		Education	6;24031	5.13	<0.001
	Household location		2;24031	7.22	0.001
		Household location	6;6010	2.19	0.041
	Risk for infection		2;24031	5.65	0.004
		Risk for infection	6;24031	7.28	<0.001
	Risk for severity		2;24031	3.32	0.036
		Risk for severity	6;24031	3.2	0.004
	Risk for anxiety		2;24031	66.6	<0.001
		Risk for anxiety	6;24031	7.0	<0.001

*Cells values in the column (df) represent the degrees of freedom for numerator and denominator.

Modeling analysis

The repeated mixed model analysis, mixing both individual household and AIC levels, due to the effects of the first wave of the COVID-19 pandemic, was conducted to describe the relationship between selected predictors and the dependent variables of food consumption and food purchasing. The two models at both levels include the same predictors, education, household composition, household location, and perceived risk of infection, severity, and anxiety, with the second level additionally analyzing the effect of AIC itself as a predictor.

Results for the models describing changes in consumption and purchasing due to the COVID-19 pandemic are presented in Table 6. The models explain food consumption and purchasing change in the behavior at both the individual and AIC levels. General consumption changes increase on average by.014 (–0.019;0.046), while purchasing change decreases by.270 (–0,321; –0,219). Both consumption and purchasing change vary significantly at the individual and AIC levels. The results in terms of the association between predictors and outcomes for food consumption show significant variation between the categories of education, risk of infection, and severity at the individual household level, while household composition and risk of infection vary significantly at the AIC level. In terms of purchasing change, significant variation was observed for all predictors on both levels.

In the between-subject analysis, using the pairwise comparison tests on the predictor levels' marginal means at the individual household level, we detect several mean change differences in each of the two main dependent variables (Table 7). For both food consumption and purchasing, the variables of education, risk of infection, and severity showed significant differences, while the variables of household composition and risk for anxiety were only significantly different for food purchasing change. The lower education category had the largest increase in food consumption and the

largest decrease in food purchasing and was significantly or notably different from the remaining two categories. People living in single-person households experienced the lowest decrease in food purchasing, which is significantly different from people living in a household with children aged 0–19. Significant differences were also observed between different categories of risk of infection and risk of severity for both dependent variables, while the categories of risk of anxiety were only significantly different for food purchasing.

Tables 8, 9 present the model post-estimation means for different categories within the AIC and individual household levels for all predictors for changes in consumption and purchasing of food due to COVID-19.

The results in Table 8 show the highest mean decrease in consumption of food for subjects with lower secondary education, especially in the Very Low AIC group. There is a gradual decrease in the mean change of food consumption from the Very High to the Very Low AIC group in all household composition categories. Households with children located in the Very Low AIC group show the highest decrease in consumption of all categories. In terms of household location, we observed a lower decrease in consumption change moving from Very Low to Very High AIC, with subjects living in urban locations generally having the lowest decrease in consumption change. Increasing the category of risk for COVID-19 infection increases the change in consumption of food for subjects located in the Very High AIC group, with those in the high-risk category showing the highest mean decreased change. Conversely, subjects located in the Very Low AIC group increase their consumption of food, thereby increasing the category of risk for infection.

In terms of purchasing changes for subject-related factors within different AIC groups shown in Table 9, we observed a clear decrease in change from Very Low to Very High AIC in almost all observed variables and corresponding levels. Subjects living in rural areas and those living in households with children showed the highest decrease in change of food purchasing in the Very Low AIC group, while no such trend was observed in the Very High AIC group.

Actual individual consumption and household composition model estimates for change in consumption and purchasing on a food categories' level

Figures 2, 3 show the estimated marginal means and standard errors of consumption changes for 11 food types at the AIC level and per household composition, respectively. The results of the pairwise comparison analysis between different

TABLE 7 Model marginal means of different individual household level effects on change in consumption and purchasing food during the COVID-19 pandemic.

Predictor variables	Category	Mean consumption change (During-before COVID-19)	Mean purchasing change (During-before COVID-19)
Education	Lower secondary or equivalent	0.058 (−0.036; 0.153)^{ab}	−0.100 (−0.249; −0.049)^{a}
	Upper secondary of equivalent	−0.019 (−0.032; −0.006)^{a}	−0.336 (−0.357; −0.316)^{b}
	University degree or equivalent	−0.002 (−0.009; 0.013)^{b}	−0.374 (−0.391; −0.357)^{c}
Household composition	Household with children 0–19	0.007 (−0.026; −0.041)	−0.293 (−0.346; −0.240)^{a}
	Single-person household	0.013 (−0.023; −0.048)	−0.248 (−0.304; −0.192)^{b}
	Households with 2 + adults without children	0.021 (−0.012; 0.054)	−0.269 (−0.321; −0.217)^{ab}
Household location	Urban	0.012 (−0.021; −0.045)	−0.243 (−0.295; −0.191)^{a}
	Intermediate	0.013 (−0.021; 0.047)	−0.271 (−0.325; −0.218)^{b}
	Rural	0.017 (−0.017; 0.051)	−0.296 (−0.350; −0.241)^{b}
Risk infection	Low	−0.010 (−0.044; 0.024)^{a}	−0.301 (−0.355; −0.248)^{a}
	Medium	0.019 (−0.015; 0.053)^{b}	−0.261 (−0.315; −0.208)^{b}
	High	0.032 (−0.003; 0.068)^{b}	−0.247 (−0.315; −0.208)^{b}
Risk severity	Low	0.041 (0.0'6; 0.075)^{a}	−0.249 (−0.303; −0.195)^{a}
	Medium	0.011 (−0.045; 0.024)^{b}	−0.268 (−0.322; −0.215)^{ab}
	High	−0.011 (−0.045; 0.024)^{c}	−0.293 (−0.347; −0.238)^{b}
Risk anxiety	Low	0.019 (−0.016; 0.053)	−0.168 (−0.222; −0.114)^{a}
	Medium	0.010 (−0.024; −0.044)	−0.275 (−0.328; −0.222)^{b}
	High	0.013 (−0.022; 0.047)	−0.367 (−0.421; −0.313)^{c}

Based on individual fixed level estimated marginal means. Higher absolute values mean bigger change. Positive signs mean increased consumption/purchasing as affected by COVID-1919, while negative signs denote decreases. Data weighted by countries. The mean differences are significant at the 0.05 level. Different superscript letters indicate differences between groups. Adjustment for multiple comparisons was conducted using the LSD method.

AIC groups and household composition categories for the consumption of different food types affected by COVID-19 show many significant differences between the analyzed types. Regarding the AIC groups, significant differences were observed in fresh meat consumption for both High and Low AIC groups (p = 0.001); fresh fish between the Low, High, and Very High groups; bread and bakery products between the Low and Very High groups; frozen food between the High and Very High groups (p = < 0.05); between all AIC groups for canned food; between the Very High group and all other groups for readymade meals; and between different groups of AIC for cake and biscuits, sweets, and alcoholic beverages consumption. Different categories of household composition were significantly different for fruits and vegetables, meat and meat products, bread and bakery products, dairy products, frozen food, cake and biscuits, and sweets.

Figures 4, 5 present the estimated marginal means and standard errors of purchasing changes for the four food types per AIC and household composition, respectively. The pairwise comparison analysis of different AIC groups and household composition categories for different food purchasing types shows significant differences. Significant differences were observed between all AIC groups in fruit and vegetables, meat and meat products, and other fresh food products purchasing change affected by COVID-19. For the other non-fresh food products, the Very High AIC group was significantly different from all other groups except from the Very Low AIC group. In the household composition groups, significant differences are observed between all levels within the fruits and vegetables purchasing type, within meat and meat products, within other fresh and non-fresh food types, and between single-person households and the other two household composition categories.

Discussion

This paper has attempted to focus on the most likely predictor and outcome variables that can help explain food behavior changes during COVID-19. The results presented in the "Results" section are striking and show that the measure of financial status we have deployed, i.e. national AIC as the main indirect predictor, and household composition as the main direct predictor, provide powerful statistically significant explanations of behavioral changes in household food consumption and purchasing. We have

TABLE 8 Model post-estimates means (*SD*) for different AIC and individual household level effects describing the change in consumption of food during the COVID-19 pandemic.

Variables	Very low AIC	Low AIC	High AIC	Very high AIC
Education				
Lower secondary or equivalent	−0.13 (0.05)	0.41 (0.00)	−0.06 (0.03)	−0.02 (0.02)
Upper secondary of equivalent	−0.06 (0.05)	−0.01 (0.03)	−0.01 (0.03)	0.00 (0.02)
University degree or equivalent	−0.03 (0.05)	0.01 (0.03)	0.02 (0.04)	0.02 (0.03)
Household composition				
Households with children 0–19	−0.10 (0.04)	0.00 (0.04)	0.01 (0.04)	0.04 (0.02)
Single-person households	−0.02 (0.04)	−0.01 (0.03)	−0.01 (0.04)	0.00 (0.02)
Households with two or more adults without children	−0.03 (0.05)	0.00 (0.03)	0.02 (0.04)	−0.01 (0.02)
Household location				
Urban	−0.03 (0.05)	−0.01 (0.04)	0.02 (0.04)	0.01 (0.03)
Intermediate	−0.05 (0.06)	0.02 (0.03)	−0.01 (0.04)	0.01 (0.03)
Rural	−0.06 (0.06)	0.01 (0.03)	0.02 (0.04)	−0.01 (0.03)
Risk of infection				
Low	−0.07 (0.05)	−0.01 (0.03)	0.00 (0.04)	0.01 (0.02)
Medium	−0.07 (0.04)	0.02 (0.02)	0.01 (0.04)	0.01 (0.02)
High	0.02 (0.04)	−0.03 (0.06)	0.04 (0.04)	−0.03 (0.03)
Risk of severity				
Low	−0.04 (0.05)	0.01 (0.03)	0.03 (0.04)	0.02 (0.02)
Medium	−0.06 (0.05)	0.01 (0.04)	0.00 (0.03)	0.01 (0.02)
High	−0.04 (0.06)	−0.02 (0.03)	0.00 (0.04)	−0.03 (0.02)
Risk of anxiety				
Low	−0.05 (0.05)	0.00 (0.04)	0.03 (0.04)	0.02 (0.02)
Medium	−0.05 (0.06)	0.00 (0.03)	0.00 (0.04)	0.00 (0.02)
High	−0.04 (0.06)	0.00 (0.04)	0.01 (0.04)	−0.01 (0.03)

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TABLE 9 Model post-estimates means (*SD*) for different AIC and individual household level effects describing the change in purchasing of food during the COVID-19 pandemic.

Variables	Very low AIC	Low AIC	High AIC	Very high AIC
Education				
Lower secondary or equivalent	−0.34 (0.10)	0.63 (0.18)	−0.39 (0.11)	−0.22 (0.11)
Upper secondary of equivalent	−0.51 (0.15)	−0.19 (0.14)	−0.38 (0.11)	−0.24 (0.11)
University degree or equivalent	−0.41 (0.13)	−0.29 (0.14)	−0.40 (0.11)	−0.28 (0.10)
Household composition				
Households with children 0–19	−0.69 (0.08)	−0.17 (0.14)	−0.42 (0.10)	−0.23 (0.10)
Single-person households	−0.34 (0.08)	−0.35 (0.13)	−0.36 (0.10)	−0.21 (0.10)
Households with two or more adults without children	−0.40 (0.09)	−0.30 (0.13)	−0.40 (0.11)	−0.28 (0.11)
Household location				
Urban	−0.39 (0.12)	−0.24 (0.16)	−0.35 (0.09)	−0.25 (0.11)
Intermediate	−0.47 (0.15)	−0.23 (0.15)	−0.40 (0.11)	−0.27 (0.10)
Rural	−0.53 (0.15)	−0.29 (0.15)	−0.43 (0.10)	−0.23 (0.11)
Risk of infection				
Low	−0.51 (0.15)	−0.22 (0.15)	−0.39 (0.10)	−0.20 (0.08)
Medium	−0.47 (0.14)	−0.23 (0.13)	−0.41 (0.11)	−0.28 (0.09)
High	−0.36 (0.10)	−0.36 (0.17)	−0.39 (0.11)	−0.38 (0.11)
Risk of severity				
Low	−0.46 (0.15)	−0.18 (0.16)	−0.35 (0.08)	−0.19 (0.07)
Medium	−0.46 (0.15)	−0.28 (0.15)	−0.38 (0.10)	−0.26 (0.08)
High	−0.45 (0.15)	−0.28 (0.13)	−0.46 (0.11)	−0.38 (0.10)
Risk of anxiety				
Low	−0.44 (0.15)	−0.08 (0.11)	−0.31 (0.05)	−0.18 (0.05)
Medium	−0.49 (0.15)	−0.27 (0.11)	−0.39 (0.06)	−0.26 (0.05)
High	−0.43 (0.15)	−0.35 (0.11)	−0.54 (0.07)	−0.42 (0.06)

also examined other predictors that contribute explanatory power to the food behavioral changes seen during the first wave of COVID-19.

Actual individual consumption's effect on food behavior changes during COVID-19

There are clear statistically significant differences between the four examined AIC groups. In terms of pandemic-related regulatory restrictions and closures, the Very High and High AIC groups were both affected less by, and more able to adapt to, such regulations. The existence of this general trend is also shown by the lockdown working ability scores that rise continuously from Very Low to Very High, demonstrating the increased availability and quality of teleworking infrastructures and how conducive to teleworking their occupational profiles are seen to be. This trend of increasing resilience of households from the low AIC end to the high end is underlined by a strong decrease in the three types of risk perception that households report, i.e., infection, severity, and anxiety, especially in terms of severity. Very similar decreasing trends are seen in the actual household COVID-19 experiences of infection, isolation, and hospitalization.

Other predictors examined along the AIC dimension include national cultural differences that also reveal significant regular changes. Both power distance and uncertainty avoidance decrease from the low AIC end to the high end, while the three cultural traits of individualism, long-term orientation, and indulgence increase toward the high end. This paints a clear picture of cultural differences, which arguably reveals quite different mindsets and worldviews that are likely to influence how individuals react to severe shocks like the COVID-19 pandemic. Examining these national cultural scores is an exercise to see whether they might offer some insight into understanding how and why different countries were affected by and reacted to the pandemic in different ways. It is clear that there are many relatively strong similarities between culture and AIC, although this by no means implies any causation between the two, and there are likely to be complex explanations and other intervening variables that would need to be considered. This is beyond the scope of this paper but might be taken up in further research.

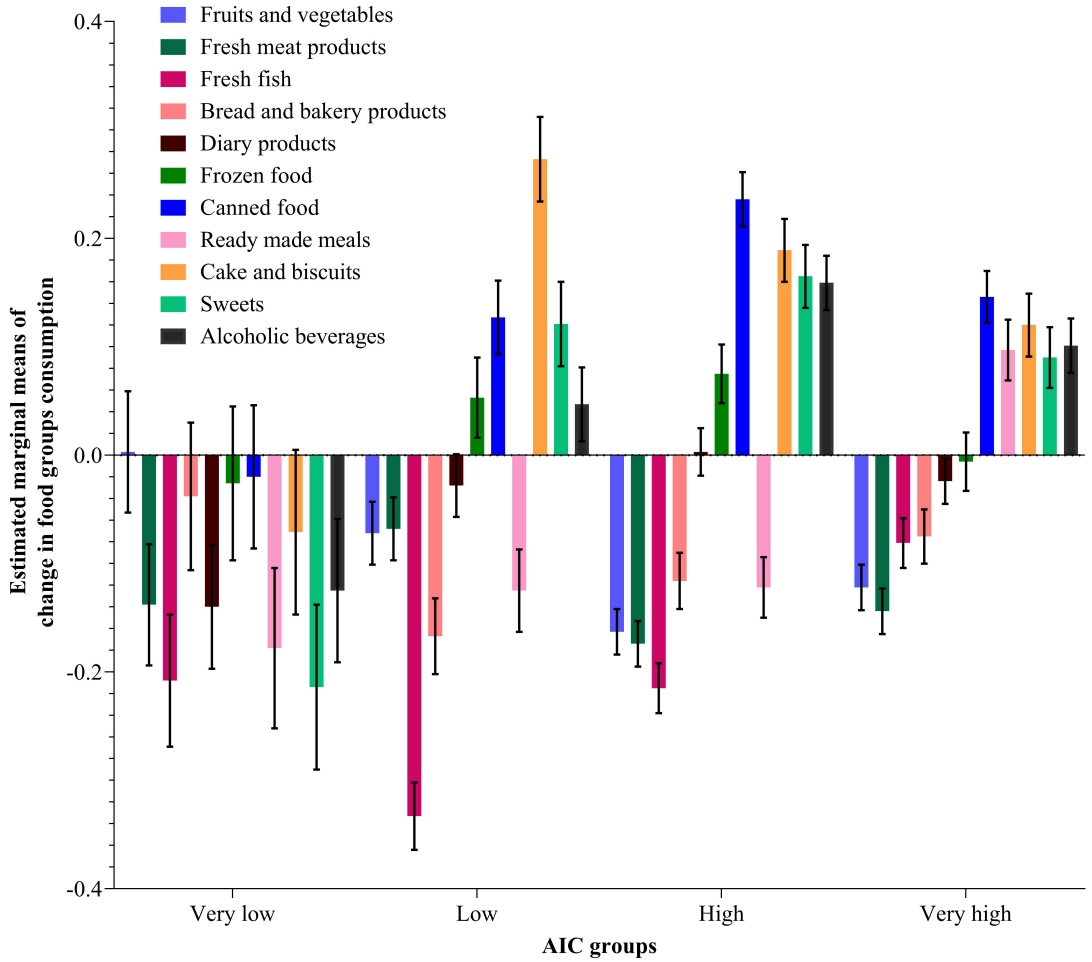

FIGURE 2
Estimated marginal means using the MANOVA procedure for different food types consumption change (During—Before COVID-19) per AIC groups. Data weighted by countries (see also **Supplementary Tables 2, 4**).

Individual household and actual individual consumption-related effects on food consumption and food purchasing change

When looking specifically at the contributions of Level 1 individual household and Level 2 AIC predictors in explaining the changes in food consumption and purchasing during COVID-19, education, household composition, and risk of infection were the most powerful or joint most powerful predictors examined in both tested models. Looking at the food consumption results, the modeling analysis in the "Modeling analysis" section showed that both the perceived COVID-19 risks of infection and education are significant or notably significant ($p < 0.1$) predictors at both the individual household and AIC levels, while the risk of COVID-19 severity was only significant at the individual household level, and household composition was only significant at the AIC level analysis. The food purchasing model shows higher exploratory power, with all predictors being significant in both individual household and AIC level analyses.

Leaving aside the power of AIC's monetary measure of consumption as an important aspect of a household's financial situation for both food consumption and purchasing, it is clear that changes in food consumption and food purchasing behavior are explained by different predictor mixes. There are a number of possible reasons for this especially, but not only, during a crisis. First, households may be forced to purchase food items that are actually available when they shop rather than items they would normally buy but cannot due to non-availability. The immense supply chain delays, shortages, and other restrictions have obviously created such constraints. Second, many people grow at least some of their food rather than purchase it, and this increased significantly during the crisis by about 25% in rural areas, where there is often more space, and about 10% in urban areas (2). In this context, some households are able to secure

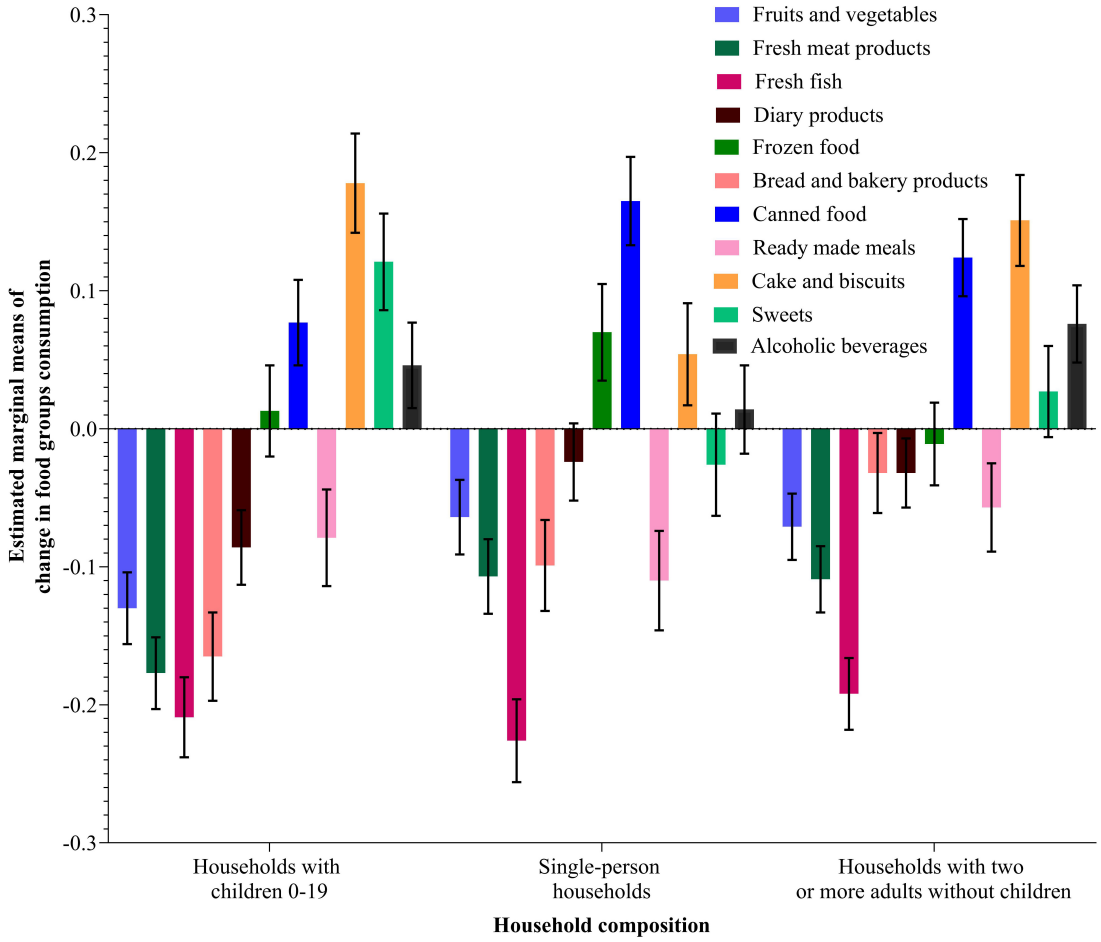

FIGURE 3
Estimated marginal means using the MANOVA procedure for different food types consumption change (During—Before COVID-19) per household composition categories. Data weighted by countries (see also **Supplementary Table 3**).

items for consumption, temporarily not available in the shops, from family or friends who do grow their own food or who have been able to stock up on specific items to share.

Turning to the specific predictor mixes in the two types of food behavior, food consumption tends to be strongly associated by each individual with their physical health, so the level of education about this link is important, as is the perceived risk of COVID-19 infection and severity. Putting food into one's body, especially during a serious pandemic, is likely to be seen as something to be taken extremely seriously. The type of household composition seems to be less powerful in this context, except perhaps when related to sensitivity about these issues where children or older persons are present in a household.

In contrast, food purchasing is much more constrained by the regulatory context of restrictions and closures in terms of where, when, and how often food shopping is possible and what is available on a given day. Thus, at the individual household level, all three COVID-19-related risk factors were confirmed as powerful predictors of food purchasing, unlike with food consumption where only risk of infection and severity were detected as significant. Additionally, where a given household is located, which is directly related to the regulatory environment and food supply, and thereby what food can be purchased, was also found important. Because of haphazard food availability during a crisis, location is also likely to affect the stocking up of food, which increased by over 50% during COVID-19 in urban areas and by about 30% in rural areas, as did lockdown restrictions and the incidence of COVID-19 infections (2). For purchasing, the type of household composition is a significant predictor at both levels, individual household and AIC, compared to food consumption, given that this helps to determine the amount and range of foodstuffs acquired, whether eventually eaten or not. In households with children, there are typically more mouths to feed and, thus, more differences in food tastes to accommodate, so stocking up is also likely to be more important than for other households, especially in the context of relatively constrained shopping opportunities. These conclusions are also strengthened through the analysis of

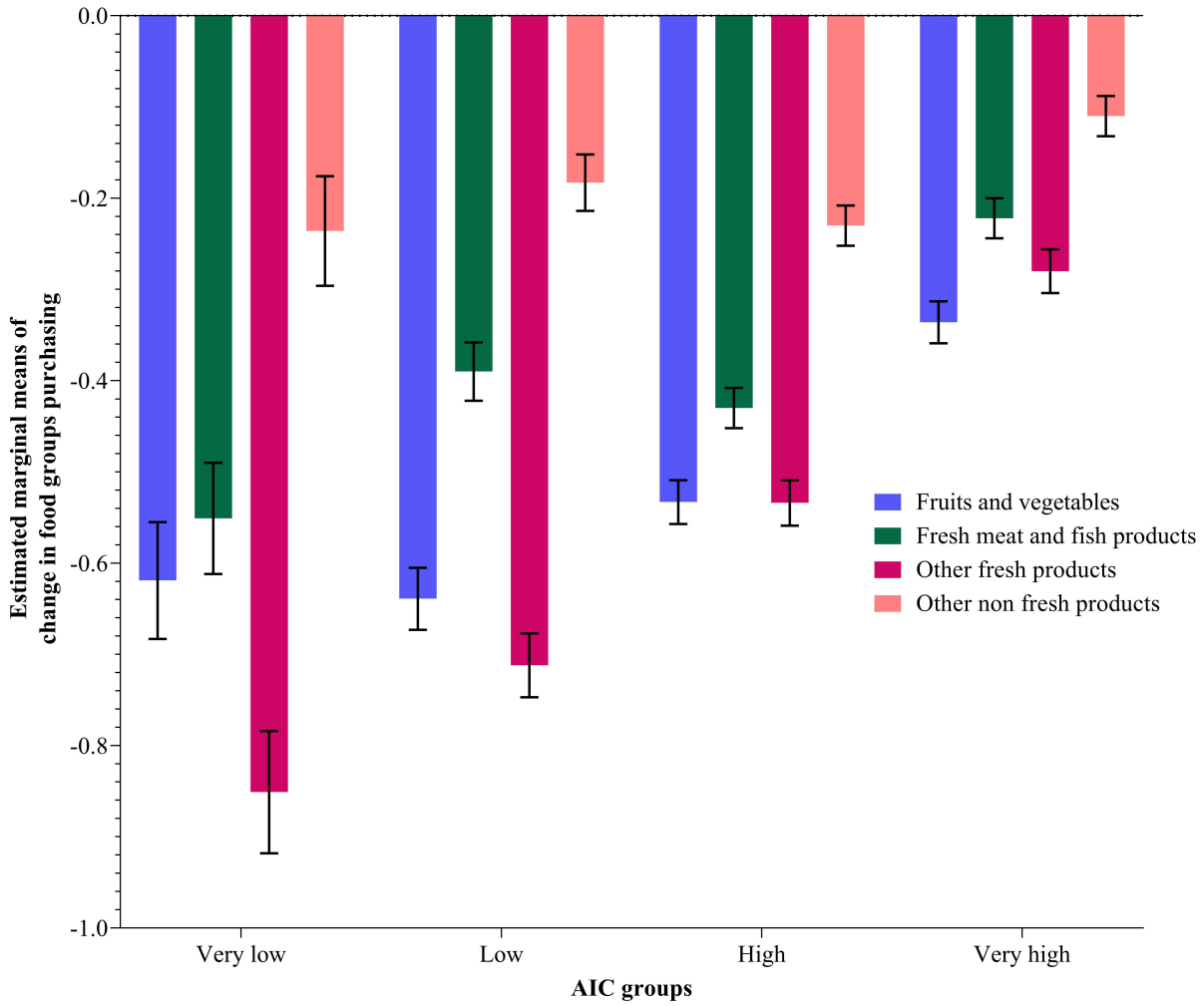

FIGURE 4
Estimated marginal means using MANOVA procedure for different food types purchasing change (During—Before COVID-19) per AIC groups. Data weighted by countries (see also **Supplementary Table 5**).

different AIC groups, which appear to be significantly associated with the change due to the COVID-19 effects on both food purchasing and consumption.

Actual individual consumption's effect on food consumption and food purchasing change on a food category level

Looking along the AIC dimension on its own, the Very Low AIC group had no increases in any type of food consumption measured in the survey and large decreases in most foods. In comparison, the Low group had higher decreases in fresh fish and bakery products than the Very Low group, but had increases in all processed foods (frozen and canned foods) and all "comfort" foods (cake, biscuits, sweets, and alcohol). On the one hand, this seems to indicate the greater financial strain on Very Low AIC households, resulting in reduced consumption of all food types measured in the survey. On the other hand, the Low AIC group, although still relatively financially strained, was nevertheless able to indulge in some increase in processed foodstuffs and very high increases in comfort foods, possibly due to some stress during the lockdown, as well as because such foods are normally cheaper than fresh foods and have longer shelf lives. In terms of the frequency of food purchasing, although all AIC groups saw only decreases, these were the greatest in the Very Low group and only slightly less large in the Low AIC group.

People living in countries in the Very High AIC group experienced the lowest decreases in fresh food consumption, as well as modest increases in processed and comfort foods. In terms of the frequency of food purchasing, although this

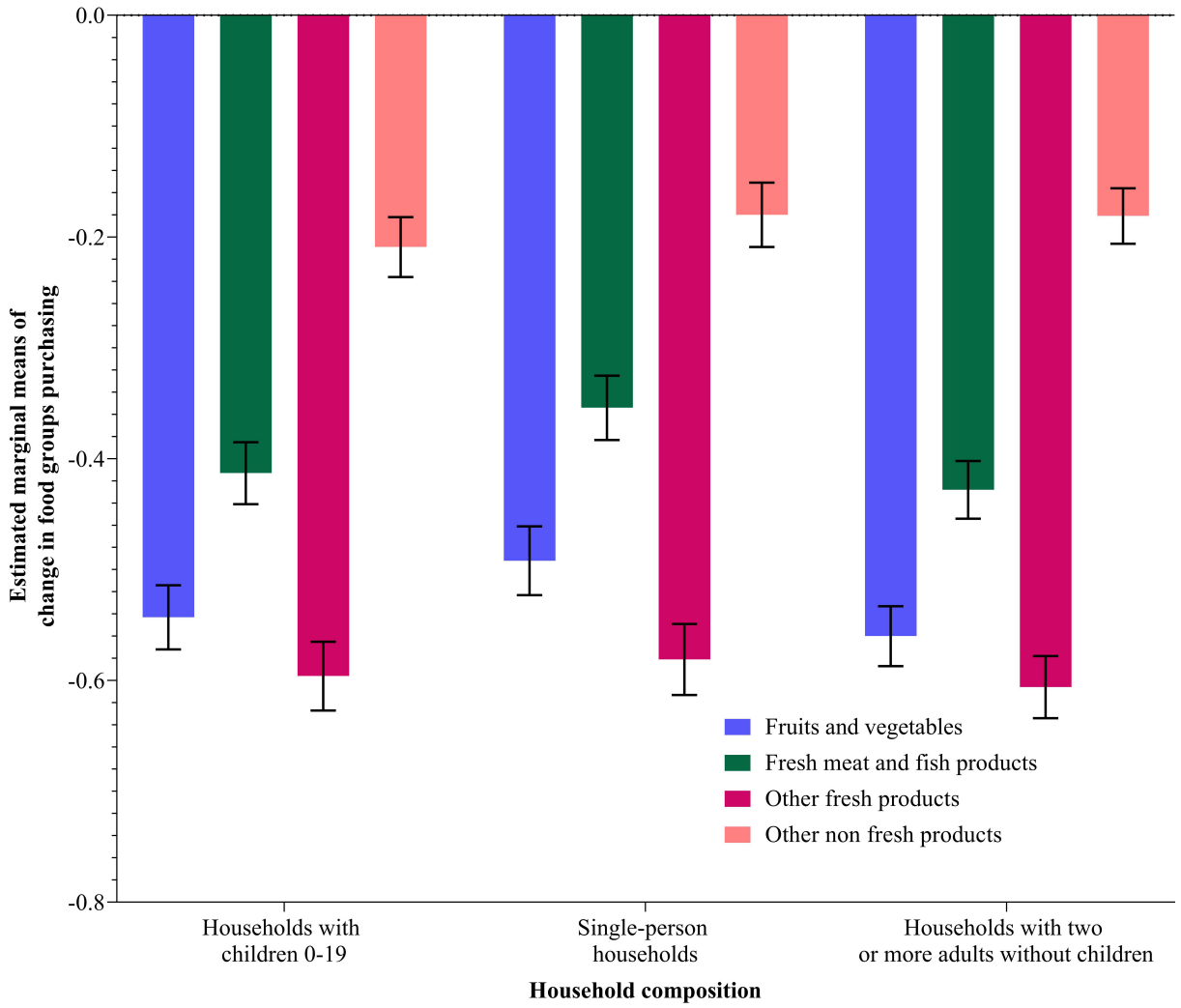

FIGURE 5
Estimated marginal means using MANOVA procedure for different food types purchasing change (During—Before COVID-19) per household composition categories. Data weighted by countries (see also **Supplementary Table 3**).

decreased across all groups and in all food types during the pandemic due to restrictive shopping possibilities, the Very High AIC group also had the lowest decrease. These households seem to have suffered much less from financial strain than the other three groups, although still subject to some, probably non-financial, stress by increasing comfort food consumption which was probably already at a relatively high level. The High Group shows similar patterns to the Very High group but with somewhat greater change, i.e., larger decreases in fresh food consumption (though not as much decrease as the Low group), and larger increases in processed and comfort food consumption. Similarly, the High Group saw smaller decreases in food purchasing than the two low groups but larger than the Very High group. Thus, the High group seems to be quite similar to the Very High group but simultaneously shares more of the characteristics of the Low group. This again underlines the view that AIC reflects important aspects of a household's financial situation and that the higher AIC groups are more financially resilient, less subject to stress, and thereby also more able to withstand the food shock of COVID-19.

Household composition effect on food consumption and food purchasing change on a food type level

Some similar conclusions can be drawn about household composition as a predictor where some household types seem generally more resilient than others. For example, households with children had the highest decreases in food consumption across all food types, except bakery products, as well as the highest overall decrease in the frequency of food purchasing.

Households with children are significantly different in their food behavior changes compared to the other two categories of households. Having children in the household is clearly a factor that increases the likelihood of changes in household food behavior during an economic shock, probably because they are more likely to be financially vulnerable as their incomes have to feed more mouths. Parents are also more likely to be concerned about the health aspects of food intake for children, especially during a pandemic, and whether they are financially able to act on this concern. In terms of food purchasing, households with two or more adults without children also saw large decreases, indeed slightly more than households with children in terms of fresh fruit and vegetables and other fresh food products. Perhaps, this reflects the lower concern in households without children as they have to eat fresh food given that they have the highest mean ages and that, while households with children are more likely to be concerned to eat fresh food, they are much more financially stretched. Single-person households show the lowest decreases in the frequency of purchase, perhaps because these households tend to be younger than other households and are, thus, less COVID-19-anxious, so they are engaged in a relatively more frequent shopping. In particular, these generally more youthful households are more likely to be food-aware, and thus continue purchasing and consuming as much fresh fruit and vegetables as possible.

Conclusion

The above observations and conclusions demonstrate the markedly different characteristics of individual households represented through the selected variables and within the four AIC groups. Other variables not considered in this paper would undoubtedly provide additional evidence, demonstrating the complexity in attempting to untangle and explain food-related COVID-19-induced behavioral changes. In this paper, we have attempted to justify our selection of the specific variables we have focused on, based on the extant literature provided through our research. However, this is constantly open to constructive criticism and improvement as our knowledge of how and why food-related behavioral change takes place.

Most of the food behavior changes charted in this paper can be interpreted as relatively negative in terms of the nutritional value of food, for example in the large decreases in fresh food consumption alongside the large increases in both processed food and comfort food products. This is perhaps unsurprising given the massive economic constraints the pandemic occasioned and the consequential social damage caused. These arguably portend the likely outcomes of any other future shocks and crises that will probably arise, whether these be further threats to health, economic disruptions due to macro-economic and political conditions, and/or to environmental degradation and stress. Indeed, it is already the case that these and other crises are intrinsically interrelated (25).

This paper attempts to contribute to food behavior research in the context of COVID-19 as a severe socio-economic shock and to assist in pinpointing potential weak points in existing food systems and broader policies that should be addressed given the likelihood of similar future shocks. At least in the European context, but arguably also more widely and without at all dismissing important national variations, it is clear from this paper that the main predictors of negative food behavior change, and thus, the main weak points in the present system that need to be addressed, are the following:

- Of first rank importance is the need to support households' financial resilience, especially for those already financially strained.
- The importance of ensuring that different categories of households are addressed in relation to their specific needs (whether with or without children and the household's age spectrum), thereby, eschewing a one-size-fits-all approach.
- Communicating and supporting transparent messaging and policies to raise awareness of particular food and health issues both during a crisis, as well as more generally, and to mitigate the anxiety and risk stresses that any crisis throws up. Behavioral science approaches are needed; for example, that provide suitable "nudges" making it easier for individuals and households to make good decisions about healthy food and diets. This also needs to be recognized that there are educational and awareness differences in different population cohorts and locations.
- Recognizing the importance of place and where households live, especially the significant differences and needs of urban and rural locations.

This paper also demonstrates the differential effects of lockdowns, restrictions, and closures on how food behavior changes, as well as the clear relationship between national cultural traits and financial resilience, although more research should focus on these issues. Clearly, strengthening and increasing the resilience of both health and food systems as critical sectors of the economy also require high-priority consideration, but these issues have not been directly addressed in this paper.

Data availability statement

The original contributions presented in this study are included in the article/**Supplementary material**, further inquiries can be directed to the corresponding author.

Author contributions

HH devised the overall focus and approach of the manuscript and undertook the data preparation and statistical analyses. JM undertook the main writing and interpretation of the results, supported by HH and IP. IP and MJ provided critical reviews and comments. All authors, together with all organizations listed in the Acknowledgment section, prepared the dataset used for this article, while HH prepared additional variables needed specifically for the manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fnut.2022.869091/full#supplementary-material

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