Heliyon 9 (2023) e21585

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon

Call for emergency action to restore dietary diversity and protect global food systems in times of COVID-19 and beyond: Results from a cross-sectional study in 38 countries

Maha Hoteit [a,*], Reem Hoteit [b], Ayoub Aljawaldeh [c], Kathleen Van Royen [d,e], Sara Pabian [e,f], Paulien Decorte [e], Isabelle Cuykx [e], Lauranna Teunissen [e], Charlotte De Backer [e], the Corona Cooking Survey Study Group[1]

[a] Food Sciences Unit, National Council for Scientific Research-Lebanon (CNRS-L), Beirut, P.O. Box 11-8281, Lebanon
[b] Clinical Research Institute, Faculty of Medicine, American University of Beirut, Beirut, Lebanon
[c] World Health Organization Regional Office for the Eastern Mediterranean, Cairo, Egypt
[d] Department of Communication Sciences, Faculty of Social Sciences, University of Antwerp, Antwerp, Belgium
[e] Department of Primary and Interdisciplinary Care, University of Antwerp, Antwerp, Belgium
[f] Department of Communication and Cognition, Tilburg University, Tilburg, Netherlands

ARTICLE INFO

Keywords:
COVID-19
Pandemics
Food consumption pattern
Dietary diversity
Food consumption score
Food-related behaviors

ABSTRACT

Background: The COVID-19 pandemic has revealed the fragility of the global food system, sending shockwaves across countries' societies and economy. This has presented formidable challenges to sustaining a healthy and resilient lifestyle. The objective of this study is to examine the food consumption patterns and assess diet diversity indicators, primarily focusing on the food consumption score (FCS), among households in 38 countries both before and during the first wave of the COVID-19 pandemic.
Methods: A cross-sectional study with 37 207 participants (mean age: 36.70 ± 14.79, with 77 % women) was conducted in 38 countries through an online survey administered between April and June 2020. The study utilized a pre-tested food frequency questionnaire to explore food consumption patterns both before and during the COVID-19 periods. Additionally, the study computed Food Consumption Score (FCS) as a proxy indicator for assessing the dietary diversity of households.
Findings: This quantification of global, regional and national dietary diversity across 38 countries showed an increment in the consumption of all food groups but a drop in the intake of vegetables and in the dietary diversity. The household's food consumption scores indicating dietary diversity varied across regions. It decreased in the Middle East and North Africa (MENA) countries, including Lebanon ($p < 0.001$) and increased in the Gulf Cooperation Council countries including Bahrain ($p = 0.003$), Egypt ($p < 0.001$) and United Arab Emirates ($p = 0.013$). A decline in the household's dietary diversity was observed in Australia ($p < 0.001$), in South Africa including Uganda ($p < 0.001$), in Europe including Belgium ($p < 0.001$), Denmark ($p = 0.002$), Finland ($p < 0.001$) and Netherland ($p = 0.027$) and in South America including Ecuador ($p < 0.001$), Brazil ($p < 0.001$), Mexico ($p < 0.0001$) and Peru ($p < 0.001$). Middle and older ages [OR = 1.2; 95 % CI = [1.125–1.426] [OR = 2.5; 95 % CI = [1.951–3.064], being a woman [OR = 1.2; 95 % CI =

* Corresponding author.
E-mail address: maha.hoteit@cnrs.edu.lb (M. Hoteit).
[1] All names in the research group are listed as co-authors.

https://doi.org/10.1016/j.heliyon.2023.e21585
Received 7 March 2023; Received in revised form 20 October 2023; Accepted 24 October 2023
Available online 8 November 2023

[1.117–1.367], having a high education ($p < 0.001$), and showing amelioration in food-related behaviors [OR = 1.4; 95 % CI = [1.292–1.709] were all linked to having a higher dietary diversity.

Conclusion: The minor to moderate changes in food consumption patterns observed across the 38 countries within relatively short time frames could become lasting, leading to a significant and prolonged reduction in dietary diversity, as demonstrated by our findings.

1. Introduction

The World Health Organization declared Coronavirus Disease 2019 (COVID-19) a pandemic in March 2020, and it has since become an unprecedented public health concern that has resulted in economic and social crises [1,2]. Before the COVID-19 pandemic brought the entire world to a halt, nearly 690 million individuals globally were consuming fewer calories than they needed in 2019, with many of them suffering from chronic and extreme hunger [3]. This has occurred as a result of several circumstances, including but not limited to political conflict, low socioeconomic conditions, natural catastrophes, climate change, and pests [4]. The undeniable significance of individuals' and communities' food consumption habits and dietary variety is evident in the pronounced impacts on both physical and mental health resulting from undernutrition [3,5].

Global food-insecurity alerts have been issued due to food shortages, rising food prices such as wheat and rice, and/or income loss due to rising unemployment rates [6]. According to Torero et al. global lockdowns caused by COVID-19 have hampered all stages of the global food supply chain, from farm to fork [6]. As a result, over 122 million more people are facing hunger in the world since 2019 due to the pandemic and repeated weather shocks and conflicts, including the war in Ukraine [7,8]. Also, Approximately 2.4 billion individuals, largely women and residents of rural areas, did not have consistent access to nutritious, safe, and sufficient food in 2022 [7,8].

Studies have shown that the COVID-19 pandemic has led to changes in the eating behavior of individuals including dietary patterns and food selection. The escalation of COVID-19's economic impact has exacerbated food insecurity. Consumers, grappling with financial constraints, tend to restrict their purchases to affordable food categories, such as starches, while cutting back on more expensive options like meat and fish [9]. The global surge in the accessibility of low-cost, calorie-dense foods, frequently derived from staple cereal crops, has mitigated hunger for many. However, this has often occurred at the cost of dietary diversity and the promotion of local, typically healthier, diets [9]. Food insecure consumers may also consume more savory snacks, sweets, and candies as a result of their emotional state and worry connected to food supply, which can lead to weight gain [10,11]. Equal enhancement in access to a variety of micronutrient-rich foods, including fresh fruits, vegetables, legumes, pulses, and nuts, has not been realized across all segments of the population. Meanwhile, there has been a rise in the affordability and widespread availability of unhealthy foods containing high levels of salt, sugars, saturated fats, and trans fats [10,11].

Before and during the pandemic, most countries had been collecting food consumption data to monitor consumer's food intake and patterns [12]. In the midst of the pandemic, each country or region assessed how lockdown measures, stemming from the first wave of the COVID-19 pandemic, influenced changes in dietary habits: some focusing on food safety issues, on food availability, what changed during the pandemic and following the pandemic [13,14]. Comparing regional data with elsewhere offers the opportunity to see which practices are effective in each region and provides more information to help predict trends in consumer behaviors and diet quality during the post-pandemic recovery period. Moreover, unhealthy diets, the array of burdens stemming from malnutrition, and non-communicable diseases (NCDs) are closely linked. Unhealthy diets have become a primary source of poor health and environmental degradation around the world, with glaring disparities between rich and poor [15]. To date, as indicated by a recent systematic review, there has been an uptick in the frequency of meals per day, a rise in home-cooked meals, and an increase in the intake of fruits and vegetables. However, the data regarding changes in diet quality were mixed and conflicting [16]. For instance, according to Pung et al., breakfast was the most skipped meal among learning undergraduates in Malysia [17]. On the contrary, participants engaged in remote work reported consistent daily consumption of either breakfast, lunch, or dinner during the COVID-19 pandemic, as detailed in the study by Tan et al. [18]. The majority of these respondents had a daily intake of vegetables, bread/rice/noodles and meat/chicken, with at least two occurrences per day [18].

In numerous studies, there is an overlap between the dietary diversity of households and food insecurity. The evaluation of household dietary patterns differs significantly across studies, and notably, a comprehensive assessment of alterations in household dietary diversity, as indicated by changes in validated dietary indexes such as the Food Consumption Score (FCS), is frequently absent [16]. In addition, most of the published studies describe the patterns of consumption among individuals.

Therefore, the objective of this study is to examine the food consumption patterns and assess diet diversity indicators, primarily focusing on the food consumption score (FCS), among households in 38 countries both before and during the first wave of the COVID-19 pandemic.

2. Materials and methods

2.1. Study design and setting

In a comprehensive online survey spanning 38 countries worldwide, a cross-sectional approach was employed [19]. This involved

Table 1
Sociodemographic and socioeconomic characteristics of the studied population (N = 37 207).

Variables	Overall N = 37 207 n (%)	Male N = 8539 n (%)	Female N = 28 668 n (%)	P-value
Age (mean ± SD)	36.70 ± 14.79	38.76 ± 15.78	36.08 ± 14.44	<0.001
Young adults (18–39)	22900 (61.5)	4854 (56.8)	18046 (62.9)	<0.001
Middle-aged adults (40–59)	10828 (29.1)	2547 (29.8)	8281 (28.9)	
Elderly (60+)	3479 (9.4)	1138 (13.3)	2341 (8.2)	
Country of residence during COVID-19				
Australia	533 (1.4)	44 (0.5)	489 (1.7)	
Austria	362 (1.0)	61 (0.7)	301 (1.0)	
Bahrein	693 (1.9)	126 (1.5)	567 (2.0)	
Belgium	6886 (18.5)	1398 (16.4)	5488 (19.1)	
Brazil	546 (1.5)	150 (1.8)	396 (1.4)	
Canada	844 (2.3)	165 (1.9)	679 (2.4)	
Chile	863 (2.3)	272 (3.2)	591 (2.1)	
China	539 (1.4)	334 (3.9)	205 (0.7)	
Denmark	835 (2.2)	430 (5.0)	405 (1.4)	
Ecuador	775 (2.1)	288 (3.4)	487 (1.7)	
Egypt	734 (2.0)	170 (2.0)	564 (2.0)	
Finland	791 (2.1)	64 (0.7)	727 (2.5)	
France	232 (0.6)	66 (0.8)	166 (0.6)	
Germany	662 (1.8)	277 (3.2)	385 (1.3)	
Greece	800 (2.2)	270 (3.2)	530 (1.8)	
Ireland	496 (1.3)	121 (1.4)	375 (1.3)	
Italy	315 (0.8)	59 (0.7)	256 (0.9)	
Japan	577 (1.6)	280 (3.3)	297 (1.0)	
Jordan	2675 (7.2)	581 (6.8)	2094 (7.3)	
Kuwait	728 (2.0)	156 (1.8)	572 (2.0)	
Lebanon	2282 (6.1)	436 (5.1)	1846 (6.4)	
Mexico	623 (1.7)	163 (1.9)	460 (1.6)	
Netherlands	778 (2.1)	139 (1.6)	639 (2.2)	
New Zealand	2982 (8.0)	313 (3.7)	2669 (9.3)	
Oman	186 (0.5)	32 (0.4)	154 (0.5)	
Palestine	859 (2.3)	177 (2.1)	682 (2.4)	
Peru	589 (1.6)	142 (1.7)	447 (1.6)	
Poland	550 (1.5)	248 (2.9)	302 (1.1)	
Qatar	653 (1.8)	135 (1.6)	518 (1.8)	
Romania	325 (0.9)	69 (0.8)	256 (0.9)	
Saudi Arabia	2999 (8.1)	530 (6.2)	2469 (8.6)	
Singapore	113 (0.3)	42 (0.5)	71 (0.2)	
South Africa	138 (0.4)	21 (0.2)	117 (0.4)	
Spain	730 (2.0)	177 (2.1)	553 (1.9)	
Uganda	320 (0.9)	159 (1.9)	161 (0.6)	
United Arab Emirates	1718 (4.6)	313 (3.7)	1405 (4.9)	
United Kingdom	205 (0.6)	63 (0.7)	142 (0.5)	
United States	271 (0.7)	68 (0.8)	203 (0.7)	
Education				<0.001
Under a high school diploma	1479 (4.0)	502 (5.9)	977 (3.4)	
High school diploma or equivalent	8666 (23.3)	2267 (26.6)	6399 (22.3)	
Bachelor's degree	16722(45.0)	3208 (37.6)	13514 (47.1)	
Master's degree	8040 (21.6)	1801 (21.1)	6232 (21.7)	
Doctorate	2294 (6.2)	753 (8.8)	1541 (5.4)	
Number of cohabiting adults (Before lockdown) (mean ± SD)	2.78 ± 2.19	2.63 ± 2.08	2.82 ± 2.22	0.001
Less than 3	4856 (55.4)	1115 (57.9)	3741 (54.7)	0.023
3 to 5	2973 (33.9)	628 (32.6)	2345 (34.3)	
More than 5	937 (10.7)	182 (9.5)	755 (11.0)	
Number of adults living in the same residence (During lockdown)	2.38 ± 1.97	2.22 ± 1.83	2.42 ± 2.00	<0.001
Less than 3	23742 (63.8)	5690 (66.6)	18052 (63.0)	<0.001
3 to 5	10721 (28.8)	2364 (27.7)	8357 (29.2)	
More than 5	2744 (7.4)	485 (5.7)	2259 (7.9)	
Number of cohabiting children (Before lockdown)	1.21 ± 1.68	1.24 ± 1.71	1.21 ± 1.66	0.450
Less than 3	7243 (82.6)	1603 (83.3)	5640 (82.4)	0.633
3 to 5	1317 (15.0)	276 (14.3)	1041 (15.2)	
More than 5	206 (2.3)	46 (2.4)	160 (2.3)	
Number of cohabiting children (During lockdown)	1.05 ± 1.44	0.95 ± 1.43	1.08 ± 1.44	<0.001
Less than 3	32090 (86.2)	7544 (88.3)	24546(85.6)	<0.001
3 to 5	4644 (12.5)	882 (10.3)	3762 (13.1)	
More than 5	473 (1.3)	113 (1.3)	360 (1.3)	
Employment Status (Before lockdown)				
Student	9571 (25.7)	1851 (21.7)	7720 (26.9)	<0.001

(*continued on next page*)

Table 2
Food consumption score of studied population before and during the COVID-19 pandemic.

Main Outcome		Country: Australia n (%)	Austria n (%)	Bahrein n (%)	Belgium n (%)	Brazil n (%)	Canada n (%)	Chile n (%)	China n (%)	Denmark n (%)	Ecuador n (%)	Egypt n (%)	Finland n (%)	France n (%)	P-value
FCS pre-COVID-19 pandemic		108.73 ± 34.27	82.77 ± 30.47	107.70 ± 43.40	93.45 ± 27.84	108.49 ± 36.55	95.30 ± 31.80	82.89 ± 33.75	137.23 ± 66.68	89.34 ± 35.55	101.96 ± 44.62	104.83 ± 44.27	108.53 ± 32.06	94.17 ± 38.76	<0.001
FCS during the COVID-19 pandemic		105.71 ± 35.10	83.18 ± 30.11	111.22 ± 48.05	92.72 ± 27.76	102.32 ± 35.18	94.44 ± 32.00	83.17 ± 35.28	137.29 ± 66.54	87.18 ± 35.09	93.92 ± 46.90	109.46 ± 44.66	104.95 ± 31.44	95.42 ± 41.07	
P-value		<0.001	0.654	0.003	<0.001	<0.001	0.231	0.759	0.964	0.002	<0.001	<0.001	<0.001	0.451	
FCS pre-COVID-19 pandemic	Low	12 (2.25 %)	35 (9.67 %)	38 (5.48 %)	183 (2.66 %)	9 (1.65 %)	24 (2.84 %)	73 (8.46 %)	42 (7.79 %)	70 (8.38 %)	62 (8 %)	62 (8.45 %)	10 (1.26 %)	20 (8.66 %)	<0.001
	High	521 (97.75 %)	327 (90.33 %)	655 (94.52 %)	6699 (97.34 %)	537 (98.35 %)	820 (97.16 %)	790 (91.54 %)	497 (92.21 %)	765 (91.62 %)	713 (92 %)	672 (91.55 %)	781 (98.74 %)	211 (91.34 %)	
FCS during the COVID-19 pandemic	Low	11 (2.06 %)	28 (7.73 %)	38 (5.48 %)	198 (2.88 %)	14 (2.56 %)	23 (2.73 %)	85 (9.85 %)	47 (8.72 %)	83 (9.94 %)	101 (13.03 %)	48 (6.54 %)	8 (1.01 %)	19 (8.23 %)	<0.001
	High	522 (97.94 %)	334 (92.27 %)	655 (94.52 %)	6684 (97.12 %)	532 (97.44 %)	821 (97.27 %)	778 (90.15 %)	492 (91.28 %)	752 (90.06 %)	674 (86.97 %)	686 (93.46 %)	783 (98.99 %)	212 (91.77 %)	
Percentage of decline in the high FCS		−0.19 %	−1.93 %	0.00 %	0.22 %	0.92 %	−0.12 %	1.39 %	0.93 %	1.56 %	5.03 %	−1.91 %	−0.25 %	−0.43 %	
p-value		1.000	0.230	1.000	0.273	0.267	1.000	0.219	0.442	0.117	<0.001	0.099	0.727	1.000	

Main Outcome		Country: Germany n(%)	Greece n (%)	Ireland n (%)	Italy n (%)	Japan n (%)	Jordan n (%)	Kuwait n (%)	Lebanon n (%)	Mexico n (%)	Netherlands n (%)	New Zealand n (%)	Oman n (%)	Palestine n (%)	P-value
FCS pre-COVID-19 pandemic		83.46 ± 32.20	87.74 ± 29.68	112.19 ± 30.75	89.00 ± 30.06	108.88 ± 43.14	93.78 ± 46.26	105.99 ± 46.62	93.97 ± 41.86	107.51 ± 39.58	92.72 ± 29.13	103.38 ± 31.01	117.46 ± 41.86	96.78 ± 46.13	<0.001
FCS during the COVID-19 pandemic		83.04 ± 34.77	88.78 ± 30.61	111.98 ± 29.64	88.43 ± 31.13	109.35 ± 43.21	93.59 ± 50.79	105.29 ± 51.72	88.12 ± 44.37	102.61 ± 36.97	91.43 ± 28.27	103.36 ± 29.92	112.10 ± 41.72	96.54 ± 50.29	
P-value		0.610	0.167	0.797	0.612	0.643	0.783	0.616	<0.001	<0.001	0.027	0.954	0.011	0.838	
FCS pre-COVID-19 pandemic	Low	63 (9.52 %)	38 (4.75 %)	4 (0.81 %)	14 (4.44 %)	27 (4.68 %)	333 (12.45 %)	48 (6.59 %)	211 (9.25 %)	19 (3.05 %)	20 (2.57 %)	53 (1.78 %)	8 (4.3 %)	90 (10.48 %)	<0.001
	High	599 (90.48 %)	762 (95.25 %)	492 (99.19 %)	301 (95.56 %)	550 (95.32 %)	2342 (87.55 %)	680 (93.41 %)	2071 (90.75 %)	604 (96.95 %)	758 (97.43 %)	2929 (98.22 %)	178 (95.7 %)	769 (89.52 %)	
FCS during the COVID-19 pandemic	Low	78 (11.78 %)	41 (5.13 %)	3 (0.6 %)	20 (6.35 %)	29 (5.03 %)	411 (15.36 %)	68 (9.34 %)	315 (13.8 %)	25 (4.01 %)	22 (2.83 %)	56 (1.88 %)	10 (5.38 %)	118 (13.74 %)	<0.001
	High	584 (88.22 %)	759 (94.88 %)	493 (99.4 %)	295 (93.65 %)	548 (94.97 %)	2264 (84.64 %)	660 (90.66 %)	1967 (86.2 %)	598 (95.99 %)	756 (97.17 %)	2926 (98.12 %)	176 (94.62 %)	741 (86.26 %)	
Percentage of decline in the high FCS		2.27 %	0.38 %	−0.20 %	1.90 %	0.35 %	2.92 %	2.75 %	4.56 %	0.96 %	0.26 %	0.10 %	1.08 %	3.26 %	
p-value		0.045	0.761	1.000	0.210	0.832	<0.001	0.010	<0.001	0.238	0.824	0.788	0.625	0.004	

Main Outcome		Country												P-value
		Peru n (%)	Poland n (%)	Qatar n (%)	Romania n (%)	Saudi Arabia n (%)	Singapore n (%)	South Africa n (%)	Spain n (%)	Uganda n (%)	United Arab Emirates n(%)	United Kingdom n (%)	United States n (%)	
FCS pre-COVID-19 pandemic		98.65 ± 33.83	97.20 ± 48.30	108.1 ± 44.0	96.79 ± 37.65	101.55 ± 47.29	91.56 ± 37.58	96.98 ± 36.86	112.90 ± 31.69	77.67 ± 39.37	106.00 ± 48.02	100.91 ± 35.25	95.67 ± 34.97	<0.001
FCS during the COVID-19 pandemic		93.54 ± 35.36	96.90 ± 49.56	107.9 ± 48.5	94.59 ± 42.11	101.71 ± 51.41	91.08 ± 38.68	95.50 ± 38.50	113.79 ± 31.53	64.87 ± 41.98	108.05 ± 51.16	99.76 ± 35.45	96.16 ± 36.99	
P-value		<0.001	0.823	0.869	0.125	0.791	0.844	0.523	0.273	<0.001	0.013	0.451	0.727	
FCS pre-COVID-19 pandemic	Low	16 (2.72 %)	54 (9.82 %)	40 (6.13 %)	19 (5.85 %)	287 (9.57 %)	8 (7.08 %)	7 (5.07 %)	14 (1.92 %)	51 (15.94 %)	139 (8.09 %)	11 (5.37 %)	11 (4.07 %)	<0.001
	High	573 (97.28 %)	496 (90.18 %)	613 (93.87 %)	306 (94.15 %)	2712 (90.43 %)	105 (92.92 %)	131 (94.93 %)	716 (98.08 %)	269 (84.06 %)	1579 (91.91 %)	194 (94.63 %)	259 (95.93 %)	
FCS during the COVID-19 pandemic	Low	29 (4.92 %)	68 (12.36 %)	45 (6.89 %)	28 (8.62 %)	340 (11.34 %)	10 (8.85 %)	12 (8.7 %)	9 (1.23 %)	99 (30.94 %)	147 (8.56 %)	14 (6.83 %)	14 (5.19 %)	<0.001
	High	560 (95.08 %)	482 (87.64 %)	608 (93.11 %)	297 (91.38 %)	2659 (88.66 %)	103 (91.15 %)	126 (91.3 %)	721 (98.77 %)	221 (69.06 %)	1571 (91.44 %)	191 (93.17 %)	256 (94.81 %)	
Percentage of decline in the high FCS		2.21 %	2.55 %	0.77 %	2.77 %	1.77 %	1.77 %	3.62 %	−0.68 %	15.00 %	0.47 %	1.46 %	1.11 %	
p-value		0.024	0.076	0.473	0.064	0.001	0.774	0.063	0.302	<0.001	0.516	0.607	0.607	

Table 1 (*continued*)

Variables	Overall N = 37 207 n (%)	Male N = 8539 n (%)	Female N = 28 668 n (%)	P-value
Employed	21228 (57.1)	5562 (65.1)	15666 (54.6)	
Unemployed	6408 (17.2)	1126 (13.2)	5282 (18.4)	
Employment Status (During lockdown)				
Student	8899 (23.9)	1728 (20.2)	7171(25.0)	<0.001
Employed	18096 (48.6)	4885 (57.2)	13211 (46.1)	
Unemployed	10212 (27.4)	1926 (22.6)	8286 (28.9)	
Working remotely				
Yes	13962 (71.7)	3431 (66.0)	10531(73.8)	<0.001
No	5500 (28.3)	1769 (34.0)	3731(26.2)	
Family income loss since the lockdown				
Yes	12393 (33.3)	3161 (37.0)	9232 (32.2)	<0.001
No	24813 (66.7)	5378 (63.0)	19435 (67.8)	

utilizing numerous native languages, as specified in Table 1. Data collection occurred from April to June 2020, featuring multiple sets of questions. Full details about the survey are accessible via Supplementary file 1.

2.2. Participants

Individuals aged 18 years and above, residing in any of the 38 participating countries during the COVID-19 pandemic, were eligible to participate in the study. To recruit respondents, convenience sampling was used. The survey was promoted on several social media platforms, as well as through press coverage and research team academic networks. Data, encompassing sociodemographic and economic information such as age, gender, educational attainment, employment status, income, and the count of both adults and children in the household were collected. Besides, the food-related behavior questions were divided into five segments, which were 1) cooking attitudes and practices related to leftovers, throwing away foods, financial barriers, and facilities, 2) groceries shopping of which many questions inquired about reaching physically the markets or preferring online groceries shopping, the time spent and the preferred places, 3) recipe selection, 4) food stock, and 5) food frequency consumption in terms of food portions per week from the following food groups (fruits, vegetables, legumes/pulses, nuts and nuts spread, processed meats/poultry/fish/alternative vegetables, unprocessed fish/poultry and meat, sweet snacks, fats and oils, whole grains, refined grains, milk, other dairy products and sugared beverages. For food frequency consumption, the survey included the following question: "How often did you eat the following (portions of) foods? Please indicate how often you consumed at least one portion of the following foods and drinks." Respondents were instructed to answer each item twice when it came to cooking attitudes, groceries shopping, and food frequency consumption, describing their behavior before the COVID-19 pandemic and during the COVID-19 lockdown. The findings from this questionnaire were published previously [19].

Furthermore, the Food Consumption Score (FCS), serving as a proxy indicator for assessing households' dietary diversity and nutrient intake, was calculated based on the frequency of various food groups consumed by a household in the seven days preceding the survey. The FCS score computation formula is: (starches × 2) + (pulses × 3) + vegetables + fruit+ (meat × 4) + (dairy products × 4) + (fats × 0.5) + (sugar × 0.5) [20,21]. The determination of the Food Consumption Score (FCS) involved assessing each respondent's answers related to the household's food frequency consumption per week. When devising a composite scoring system for dietary diversity, whether incorporating food frequency or not, the selection of weights is necessary and subjective. Typically, weights remain constant across analyses to enhance the standardization of the tool. Although subjective, this weighting aims to assign higher importance to foods like meat and fish, considered to have greater 'nutrient density,' while assigning lesser importance to foods like sugar. Another disadvantage of employing weights is that the score become 'stretched,' enabling a more truly continuous score and providing greater flexibility in analysis [20,21].

Before computing the FCS score, response options were consolidated into two categories: those occurring "lower than or equal to three times a week" and those happening "four times a week or more". The FCS was evaluated twice, considering food frequency consumption data both before and during the lockdown. Subsequently, it was classified as either high ($\geq$42) or low ($<$42) based on established criteria [20,21].

2.3. Statistical analysis

Using descriptive statistics, the study's demographic characteristics and other factors were summarized. Continuous variables were presented in terms of means and standard deviations (SDs), while categorical variables were represented by frequencies and percentages. Using the Shapiro–Wilk test, the data is shown to be normally distributed and the p-value exceeds 0.05.

Chi-square test was used to determine whether there was a significant association between the categorical variables (socio-demographic factors, economic factors, food-related patterns, and the consumption of food groups) and the gender, while independent *t*-test/ANOVA was applied for continuous variables (age and FCS calculation). Comparison of food consumption score which is a dichotomous variable (low or high) was performed using McNemar test (a marginal homogeneity test for paired data). To analyze the strength and direction of effect of the selected covariates on the FCS, the following formula was used:

The equation for the logistic regression model:

$\text{logit}(p) = \beta_0 + \beta_1(\text{age}_2) + \beta_2(\text{age}_3) + \beta_3(\text{gender}_2) + \beta_4(\text{education}_2) + \beta_5(\text{education}_3) + \beta_6(\text{education}_4) + \beta_7(\text{education}_5) + \beta_8(\text{employment}_2) + \beta_9(\text{employment}_3) + \beta_{10}(\text{behavior}_1) + \beta_{11}(\text{behavior}_2) + \beta_{12}(\text{behavior}_3) + \beta_{13}(\text{behavior}_4) + \beta_{14}(\text{behavior}_5) + \beta_{15}(\text{behavior}_6) + \beta_{16}(\text{behavior}_7) + \beta_{17}(\text{behavior}_8) + \beta_{18}(\text{behavior}_9) + \beta_{19}(\text{behavior}_{10})$.

- logit(p) represents the log-odds of the probability (p) of a positive outcome (higher food consumption score).
- β_0, β_1, β_2, β_3, …, β_{19} are the estimated coefficients assigned to each independent variable.
- age_2 and age_3 represent the dummy variables for the second and third age categories, respectively (with the first category serving as the reference).
- gender_2 represents the dummy variable for the second gender category (with the first category serving as the reference).
- education_2, education_3, education_4, and education_5 represent the dummy variables for the second, third, fourth, and fifth education categories, respectively (with the first category serving as the reference).
- employment_2 and employment_3 represent the dummy variables for the second and third employment categories, respectively (with the first category serving as the reference).
- behavior_1 to behavior_{10} represent the independent variables for the ten different food-related behaviors.

Backward logistic regression was used where odds ratios (ORs) and 95 % confidence intervals were estimated for each independent variable. Statistical significance was set at $p < 0.05$ and statistical analyses were performed in SPSS software, version 25.

2.4. *Ethical consideration*

This study was approved by the ethics committees at the University of Antwerp (SHW_20_46) (the project's country coordinator) and all other countries, as well. At the beginning of the survey, participants received a consent form that protected them, informed them of their rights and obligations, and ensured that their information was kept private. The analysis of the data was conducted anonymously.

3. Results

3.1. *Socio-demographic and economic characteristics*

The survey involved 37 207 participants who completed the questionnaires on behalf of their households, representing 38 countries, out of a total of 81 486 individuals who started the survey. The majority of participants were females (77.8 %). Around two-third of the participants were young adults (18–39 years) (61.5 %). The mean age of males was significantly higher than females ($t_{(37205)} = -14.73$, p-value < 0.001) (Table 1). More than two-thirds (72.8 %) had an education level of a bachelor's degree or higher, with a higher proportion of females holding bachelor's degrees compared to males ($X^2_{(4)} = 413.108$, p-value<0.001). Furthermore, 33.3 % of respondents reported a loss of family income due to the COVID-19 lockdown, with males reporting a higher incidence of loss than females in their families ($X^2_{(1)} = 68.640$, p-value<0.001). Table 1 provides further information about the sample's demographic and socio-economic characteristics.

3.2. *Consumption of food groups and calculation of food consumption score (FCS), per country*

Table S1 and Table 2 display the consumption of food groups and the Food Consumption Score (FCS), which serves as an indicator of dietary diversity, categorized by country.

3.3. *Food groups consumption (≥4 times per week) by countries*

According to the data provided in Table S1, there was a substantial increase in the consumption of fruits during the pandemic, within a range between 4.1% and 5.8 % in several European countries (Austria, Belgium, Greece and Netherlands); 3.0%–7.2 % in the EMR (Egypt, Saudi Arabia, Kuwait). Additionally, Japan witnessed an increase in fruit intake of 3.8 %. On the other hand, the Canadian, Ugandan, Bahraini, Lebanese and Palestinian populations faced a decline in fruits consumption between 3.4% and 6.6 %. Other areas and countries reported no changes in fruit consumption.

Concerning the vegetables group, it was observed that some countries faced a significant decrease in the intake of vegetables during the pandemic, including Denmark (3.9 %), Finland (3.9 %), Greece (4 %), Brazil (5.5 %), Japan (3.5 %), Jordan (8 %), Kuwait (6.6 %), Lebanon (6.9 %) and Palestine (9.6 %) while this intake remained constant in the remaining countries.

The consumption of legumes/pulses augmented significantly in many European countries including Germany (3.2 %), Greece (3.3 %), Italy (3.5 %) and Spain (5.5 %). In contrast, Belgium showed a decrease of 0.6 %. In addition to Japan (6.5 %), the Americas countries: USA (4.8 %), Chile (4 %), Mexico (4.2 %) and Peru (4.1 %) faced an increment in this food group. However, Brazil faced a decrease of 6.1 %. At the EMR level, 8 out of 10 countries witnessed an increase within a range between 0.5 % and 4.5 % of which the lowest was in Oman (0.5 %) and the highest was in UAE (4.5 %).

France ranked first in terms of nuts consumption (increase of 4.7 %) while a significant reduction was observed in Australia (5.8 %), Mexico (4 %), Ireland (3.1 %), New Zealand (2.4 %) and Denmark (1.9 %). Almost all the countries in this study faced a decrease in the consumption of processed foods. This reduction ranged between 2.4 % in Greece to 21.3 % in Ecuador.

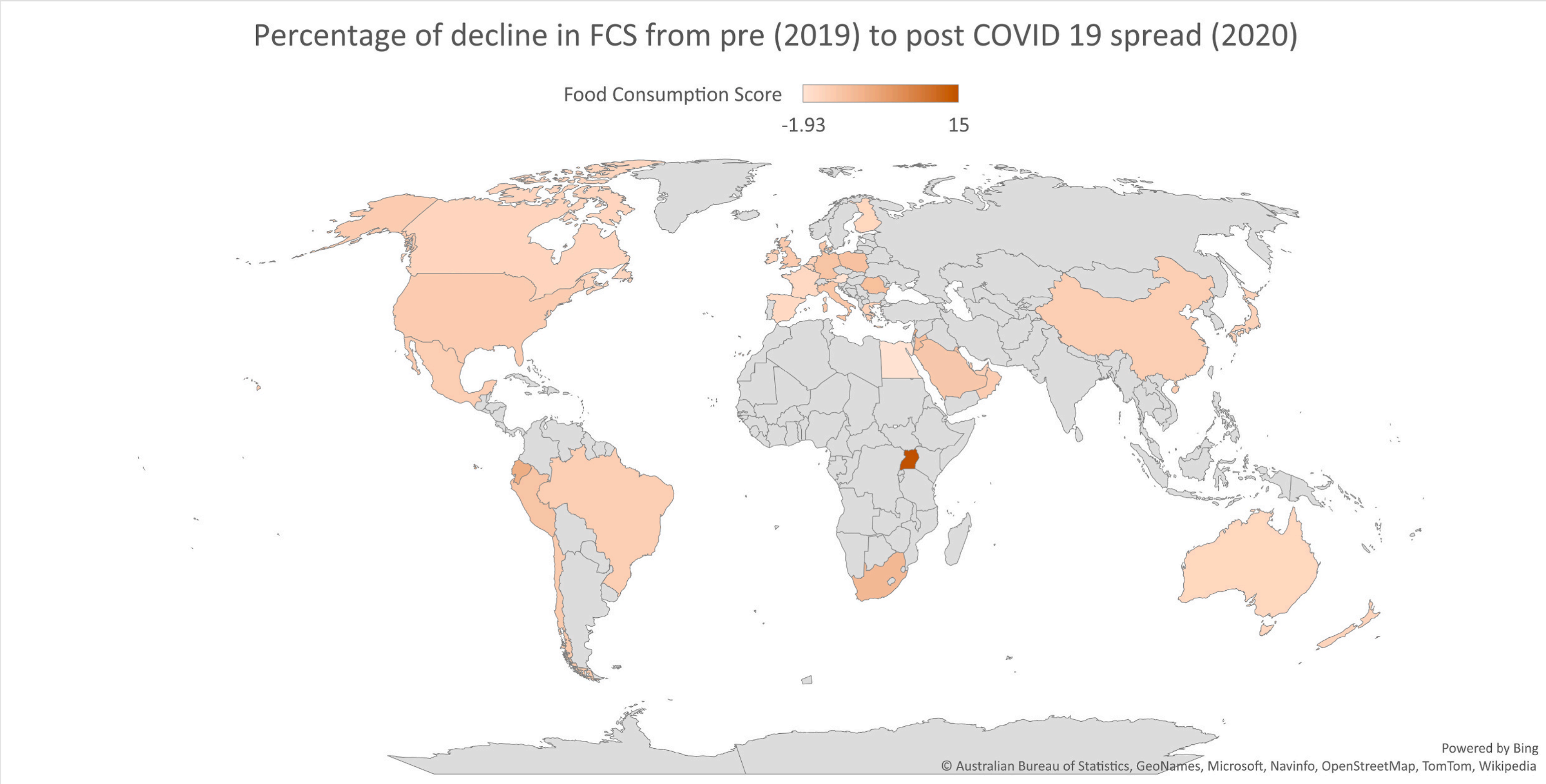

Fig. 1. The percentage of decline in the Food Consumption Score (FCS) in the countries studied pre and post the COVID-19 viruses spread in 2020.

During the pandemic, a significant increase in fish consumption was observed in many countries, including Poland, Mexico, Bahrein, Jordan, Palestine, Qatar, and UAE. Other countries, such as New Zealand and Brazil, showed a significant decrease. None of the countries listed in Table 2 faced a decrease in poultry consumption. Similarly, the meat intake increased in 8 out of 35 countries in which the highest consumption among all the countries was observed in Saudi Arabia (4.5 %).

Half of the countries included in this study experienced an increase in the consumption of sweet snacks, ranging from 2.5 % in Denmark to 13.5 % in New Zealand. Sixteen out of the 38 countries experienced a rise in the consumption of fats and oils. The highest increase was observed in Greece at 14.5 %, while the lowest was in Finland at 1.4 %. Conversely, several countries, including Chile, Lebanon, and Uganda, exhibited a decrease in fats and oils consumption. The UK experienced the highest increase at 6.4 % in whole grains consumption, where as Brazil experienced the highest decrease at 11 %. Additionally, concerning refined grains consumption, the UK recorded the highest increase at 10.2 %, while Uganda and Peru witnessed the most considerable decrease at 7.0–8.0 %.

There was a surge of milk consumption in Belgium, New Zealand, UK, Egypt and Jordan, while a decline was observed in Ecuador, Uganda and Japan. Notably, Greece (4.1 %) and the Netherlands (2 %) were the only two countries displaying a significant increase in the intake of other dairy products, such as cheese or yogurt, whereas Japan (3.5 %) and Lebanon (5.1 %) witnessed a significant decrease.

The consumption of sugared beverages exhibited variations among countries, with the most substantial increase recorded in the UK at 6.3 % and the most significant decrease in Lebanon at 3.4 %.

3.4. Food consumption score and household's dietary diversity

The household's food consumption scores, indicative of dietary diversity, exhibited regional variations. It decreased in the Middle East and North Africa (MENA) and Gulf Cooperation Council countries, followed by South Africa, Europe, and South America. A slight drop was also observed in the South Pacific Ocean, North America, Asia, East Asia, the United States, the United Kingdom, and South Africa (Table 2 and Fig. 1). Uganda displayed the lowest household's dietary diversity before the lockdown, while Germany had the lowest households' dietary diversity during the pandemic. China recorded the highest FCS both before and during the pandemic. Moreover, a significant and severe decrease in the dietary diversity among households was noted in various countries, with the sharpest decrease observed in Uganda (15 %) (Table 2).

Table 3
Predictors of inadequate dietary diversity among the populations in the 38 countries.

	Inadequate dietary diversity					
	Pre-COVID-19 pandemic			During the COVID-19 pandemic		
Independent Variable	**Exp(β) = OR**	**OR Confidence Interval**	**P-value**	**Exp(β) = OR**	**OR Confidence Interval**	**P-value**
Age						
Young adults (18–39) (Reference)	–	–	–	–	–	–
Middle-aged adults (40–59)	1.267	[1.125–1.426]	**<0.001**	1.266	[1.137–1.410]	**<0.001**
Elderly (60+)	2.445	[1.951–3.064]	**<0.001**	2.811	[2.278–3.468]	**<0.001**
Gender						
Male (Reference)	–	–	–	–	–	–
Female	1.236	[1.117–1.367]	**<0.001**	1.268	[1.156–1.391]	**<0.001**
Education level						
Under a high school diploma (Reference)	–	–	–	–	–	–
High school diploma or equivalent	2.108	[1.768–2.514]	**<0.001**	1.912	[1.622–2.255]	**<0.001**
Bachelor's degree	2.231	[1.885–2.640]	**<0.001**	2.117	[1.807–2.480]	**<0.001**
Master's degree	2.925	[2.397–3.569]	**<0.001**	2.936	[2.435–3.541]	**<0.001**
Doctorate	3.416	[2.556–4.567]	**<0.001**	3.118	[2.387–4.073]	**<0.001**
Employment status						
Student (Reference)	–	–	–	–	–	–
Employed	1.096	[0.978–1.229]	0.113	1.136	[1.016–1.269]	**0.025**
Unemployed	0.898	[0.779–1.035]	0.139	0.866	[0.775–0.969]	**0.012**
Food related behaviors (Reference = Negative)						
Plan meals to include all food groups	1.473	[1.317–1.646]	**0.000**	1.624	[1.445–1.825]	**0.000**
Think about healthy choices when deciding what to eat	1.362	[1.200–1.546]	**0.000**	1.169	[1.027–1.331]	**0.018**
Feel confident about managing money to buy healthy food	1.041	[0.925–1.172]	0.506	1.380	[1.233–1.546]	**0.000**
Use the nutritional information panel	0.975	[0.866–1.097]	0.669	0.920	[0.816–1.037]	0.174
Use other parts of food label to make food choices	1.054	[0.936–1.187]	0.384	0.890	[0.788–1.005]	0.060
Cook meals at home using healthy ingredients	1.335	[1.161–1.535]	**0.000**	1.486	[1.292–1.709]	**0.000**
Feel confident about cooking a variety of healthy meals	1.424	[1.241–1.635]	**0.000**	1.278	[1.113–1.468]	**0.000**
Change recipes to make them healthier	1.009	[0.902–1.129]	0.872	0.970	[0.869–1.083]	0.589
Cook with leftover food	1.363	[1.236–1.502]	**0.000**	1.281	[1.168–1.405]	**0.000**
Throw away leftover food	1.093	[0.996–1.199]	0.060	0.919	[0.842–1.002]	0.057

3.5. Determinants of low households' dietary diversity in the overall population

Prior to the pandemic, the dietary diversity of middle-aged adults was 1.2 times higher than that of young adults (OR = 1.2; 95 % CI = [1.125–1.426]), while the dietary diversity, as indicated by the FCS, for the elderly was 2.5 times that of young adults (OR = 2.5; 95 % CI = [1.951–3.064]). Similar odds were observed in relation to age during the pandemic ($p < 0.001$) (Table 3).

Before and during the lockdown, the odds of dietary diversity among females was 1.2 times higher than that of males (OR = 1.2) with a 95 % CI of [1.117–1.367] before the lockdown and [1.156–1.391] during the lockdown. The FCS among individuals with master's or doctorate degrees was three times higher than among those with less than a high school diploma, both before and during the pandemic ($p < 0.0001$).

During the lockdown, unemployed individuals exhibited a 14 % lower FCS compared to students (OR = 0.866, p-value = 0.012), and the odds of FCS among those employed was 1.1 times higher than students (OR = 1.1; 95 % CI = [1.016–1.269]).

Individuals who demonstrated an enhancement in food-related behaviors, both before and during the lockdown, had a FCS that was 1.4 times higher than those who did not (OR = 1.4) with a 95 % CI of [1.161–1.535] before the lockdown and [1.292–1.709] during lockdown (Table 3). Further predictors related to food-related behaviors are detailed in Table 3.

4. Discussion

The objective of this study was to examine the food consumption patterns and assess the households' dietary diversity indicators, in 38 countries both before and during the first wave of the COVID-19 pandemic. With the exception of vegetables and processed meats, practically every food group saw a rise in intake due to the lockdown. However, in the majority of countries, the total score of the FCS, used to categories household (HH) dietary diversity, has decreased as compared to the period prior to the pandemic. The data collected for calculating the FCS in this study also contains untapped information that can be used to shed light on nutrient-rich groups consumed by the HH, which are crucial for nutritional health and well-being. These include protein, iron, and vitamin A.

Furthermore, our findings published previously in De Backer et al., showed a significant amelioration in certain food-related behaviors, encompassing aspects such as cooking, recipe selection, grocery shopping and food stock [19]. Also, stocking up on pasta, rice, grains, flour, and vegetables increased significantly in most countries [19]. In this study, a higher FCS exhibited a significant association with middle and older ages, female gender, higher educational attainment, and improvement in food-related behaviors.

Global strategies aimed at mitigating and controlling COVID-19 infection rates have exerted a considerable impact on economic markets, encompassing production, processing, transportation, trade/export restrictions, and more. These measures have led to substantial disruptions in both the availability and accessibility of food, which are integral components of a robust food security system [20]. This was reflected in our findings, which showed a decrease in the total FCS which led to poor diversified diets in the countries studied. Despite efforts by governments to reduce food insecurity by controlling prices, supporting food stores, facilitating internet delivery, and distributing food baskets, the situation was deteriorating due to COVID-19's ramifications. Furthermore, there is a growing trend of inexpensive, highly processed, and packaged goods that have extended shelf lives. These products often contain high concentrations of trans fats, fats, sugars, and salt, contributing to a reduction in diet quality [22].

Moreover, our findings align with the results reported by Bennet et al. [23], indicating a decline in the consumption of vegetables and processed meats, along with an increase in excessive sweet consumption during the pandemic [23,24]. Other studies conducted in Europe, North and South America revealed positive shifts towards increased consumption of vegetables, fruits, milk, processed meat, and sweets [25–27].

Our previously published findings in De Backer et al., also indicated an improvement in food-related behaviors, consistent with the results of other studies that show enhanced practices and an increase in home cooking [19,23,28]. Factors such as reduced availability of eating out and/or fast-food options, along with safety concerns, could contribute to the observed increase in home cooking. A study conducted by three European countries, Poland, Austria, and the United Kingdom, uncovered a surge in the purchase of frozen items and food with a long shelf life. Also, the same study noted an increase in the daily consumption of dairy products, grains, fats, vegetables, and sweets [29,30]. These findings align with our results, as many of these food groups, particularly grains, are conducive to storage.

The global food systems must strive to provide diets that are safe, sustainable, healthy and affordable, taking into account and respecting local culture, cooking practices and knowledge. The transformation of food systems should aim to reduce the cost of nutritious foods for consumers, making healthy diets more affordable, while ensuring fair compensation for producers. This transformation should also account for the true and often hidden environmental, health and poverty costs. Such efforts have the potential to prevent the double burden of malnutrition, including diet-related NCDs, decrease health costs associated with unhealthy diets, and reduce food waste, and alleviate the social costs of greenhouse gas emissions, ultimately resulting in significant economic savings [31–33].

4.1. Strength and limitations

This study has several strengths. Firstly, it provides a comprehensive examination of changes dietary diversity during the COVID-19 crisis across 38 countries globally. The inclusion of international collaborations is crucial for understanding dietary diversity within the intricate context of ecological influences. The results affirm the anticipated relationship between the COVID-19 crisis and alterations in food and nutrition. Secondly, the study gathered information on both known personal factors and a spectrum of suspected contextual factors, capturing fluctuations. Social distancing policies, enforced in some but not all participating countries, coupled with regional variations within a single country, contributed to ample variations for testing the effects of specific lockdown policies. Finally, this study is pioneering in empirically examining factors that can either facilitate or impede aspects and determinants of dietary diversity, utilizing the food consumption score, across 38 countries worldwide.

This study has some limitations. Firstly, it is a cross-sectional study that incorporates retrospective data on the period before lockdown. The reliance on respondents to recall their consumption patterns of food groups before lockdown introduces the potential to recall bias. Due to dependance on respondents' memory, there is a potential bias in the presented eating habits. This bias may stem from the nature of the questions asked regarding food patterns before the pandemic. The study was conducted online using convenience sampling, which may result in skewed sample characteristics in certain countries. Another limitation pertains to the determination of portion size as the study did not utilize home measurements or photographs of products to aid respondents in estimating food portion sizes.

Moreover, the study faced limitations related to small effect sizes. These are more likely to occur in large samples ($N \geq 2000$) with considerable heterogeneity, where variation in context can significantly impact the ease with which the dependent variable is influenced. Our large sample size was highly heterogeneous, covering 38 countries worldwide. Additionally, over 70 % of the respondents have an education level of a bachelor's degree or higher, potentially limiting the generalizability of the findings to a broader population with limited access to online surveys, computers or WIFI connections. It is important to note that our sample was not obtained through random sampling; there was a notable overrepresentation of women. Although the size was sufficient for valid results across all groups, future data collections should implement more targeted outreach to address underrepresented populations.

5. Conclusion

The study observed significant shifts in the food consumption habits of the population, influenced by the social isolation measures imposed by the COVID-19 pandemic. There were substantial changes in the frequency of consuming various dietary groups. Overall, the findings suggest that, with a few exceptions, nutrition patterns remained relatively stable during the lockdown, with no major impact on the frequency of consuming nutritious foods.

The COVID-19 crisis in 2020 revealed the global unpreparedness to effectively manage a pandemic, exposing vulnerabilities in food systems and frameworks. Strengthening resilience is intricately tied to building capacities. Improved access to data, increased collaboration, and heightened self-sufficiency can foster greater interdependence among nations. This, in turn, can contribute to the adoption of an international food system resilience framework, facilitating a deeper understanding of the complexities and potential far-reaching impacts that disruptions in one part of the system may have on the entire food system in the future.

Data availability statement

The dataset underpinning the findings of this study is accessible upon request from the corresponding author.

CRediT authorship contribution statement

Maha Hoteit: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Supervision, Writing – original draft. **Reem Hoteit:** Data curation, Formal analysis, Writing – review & editing. **Ayoub Aljawaldeh:** Funding acquisition, Writing – review & editing. **Kathleen Van Royen:** Conceptualization, Data curation, Funding acquisition, Supervision, Writing – review & editing. **Sara Pabian:** Conceptualization, Funding acquisition, Methodology, Writing – review & editing. **Paulien Decorte:** Conceptualization, Investigation, Project administration, Writing – review & editing. **Isabelle Cuykx:** Conceptualization, Methodology, Project administration, Writing – review & editing. **Lauranna Teunissen:** Conceptualization, Data curation, Methodology, Project administration, Writing – review & editing. **Charlotte De Backer:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2023.e21585.

References

[1] G. Paslakis, G. Dimitropoulos, D.K. Katzman, A call to action to address COVID-19–induced global food insecurity to prevent hunger, malnutrition, and eating pathology, Nutr. Rev. 79 (1) (2021) 114–116.
[2] WHO, WHO Coronavirus (COVID-19) Dashboard, 2021 [cited 2021 September 27]; Available from: https://covid19.who.int/.

[3] FAO, I., UNICEF, WFP and WHO, in: In Brief to the State of Food Security and Nutrition in the World 2020. Transforming Food Systems for Affordable Healthy Diets, FAO, Rome, 2020.
[4] T. Brück, M. d`Errico, Food security and violent conflict: introduction to the special issue, World Dev. 117 (2019) 167–171.
[5] A. Pourmotabbed, et al., Food insecurity and mental health: a systematic review and meta-analysis, Publ. Health Nutr. 23 (10) (2020) 1778–1790.
[6] M. Torero, Without Food, There Can Be No Exit from the Pandemic, Nature Publishing Group, 2020.
[7] WorldBank, Food Security and COVID-19, 2021 [cited 2021 September 27]; Available from: https://www.worldbank.org/en/topic/agriculture/brief/food-security-and-covid-19.
[8] Fao, et al., The State of Food Security and Nutrition in the World 2023, Rome, 2023.
[9] N. Elsahoryi, et al., Effect of Covid-19 on food security: a cross-sectional survey, Clinical nutrition ESPEN 40 (2020) 171–178.
[10] F.J. Elgar, et al., Relative food insecurity, mental health and wellbeing in 160 countries, Soc. Sci. Med. 268 (2021), 113556.
[11] W. Mumena, Impact of COVID-19 curfew on eating habits, eating frequency, and weight according to food security status in Saudi Arabia: a retrospective study, Prog. Nutr. 22 (2021), e2020075.
[12] C. González-Monroy, et al., Eating behaviour changes during the COVID-19 pandemic: a systematic review of longitudinal studies, Int. J. Environ. Res. Publ. Health 18 (21) (2021), 11130.
[13] D.R. Bakaloudi, et al., The impact of COVID-19 lockdown on snacking habits, fast-food and alcohol consumption: a systematic review of the evidence, Clin. Nutr. 41 (12) (2022) 3038–3045.
[14] C. Mignogna, et al., Impact of nationwide lockdowns resulting from the first wave of the COVID-19 pandemic on food intake, eating behaviors, and diet quality: a systematic review, Adv. Nutr. 13 (2) (2022) 388–423.
[15] A. Al-Jawaldeh, et al., Implementation of WHO recommended policies and interventions on healthy diet in the countries of the Eastern Mediterranean region: from policy to action, Nutrients 12 (12) (2020) 3700.
[16] P.G. Della Valle, et al., Adherence to the Mediterranean Diet during the COVID-19 national lockdowns: a systematic review of observational studies, Acta Biomed.: Atenei Parmensis 92 (Suppl 6) (2021).
[17] C.Y.Y. Pung, et al., Eating behaviors among online learning undergraduates during the COVID-19 pandemic, Int. J. Environ. Res. Publ. Health 18 (23) (2021), 12820.
[18] C.X. Tan, et al., Eating behavior among remote working adults during the COVID-19 pandemic, Nutr. Food Sci. 52 (8) (2022) 1302–1313.
[19] C. De Backer, et al., An evaluation of the COVID-19 pandemic and perceived social distancing policies in relation to planning, selecting, and preparing healthy meals: an observational study in 38 countries worldwide, Front. Nutr. 7 (2021), 621726.
[20] WFP, V., Food Consumption Analysis: Calculation and Use of the Food Consumption Score in Food Security Analysis, WFP, Rome, 2006.
[21] FAO, Food Security and Livelihoods Assessment of Lebanese Host Communities, 2015 [cited 2021 September 7]; Available from: http://www.fao.org/documents/card/en/c/926b8083-6cc6-42d9-8a28-84cf0e19be94/.
[22] FAO, Food Security Information Network, Global Report on Food Crises, 2020.
[23] G. Bennett, et al., The impact of lockdown during the COVID-19 outbreak on dietary habits in various population groups: a scoping review, Front. Nutr. 8 (2021) 53.
[24] V. Kriaucioniene, et al., Associations between changes in health behaviours and body weight during the COVID-19 quarantine in Lithuania: the Lithuanian COVIDiet Study, Nutrients 12 (10) (2020) 3119.
[25] L. Marty, et al., Food choice motives and the nutritional quality of diet during the COVID-19 lockdown in France, Appetite 157 (2021), 105005.
[26] M. Górnicka, et al., Dietary and lifestyle changes during COVID-19 and the subsequent lockdowns among Polish adults: a cross-sectional online survey PLifeCOVID-19 study, Nutrients 12 (8) (2020) 2324.
[27] D.C. Malta, et al., The COVID-19 Pandemic and Changes in Adult Brazilian Lifestyles: a Cross-Sectional Study, Epidemiologia e Serviços de Saúde, 2020, p. 29, 2020.
[28] L. Di Renzo, et al., Eating habits and lifestyle changes during COVID-19 lockdown: an Italian survey, J. Transl. Med. 18 (2020) 1–15.
[29] H.H. Chang, C.D. Meyerhoefer, COVID-19 and the demand for online food shopping services: empirical Evidence from Taiwan, Am. J. Agric. Econ. 103 (2) (2021) 448–465.
[30] M. Skotnicka, et al., Dietary habits before and during the COVID-19 epidemic in selected European countries, Nutrients 13 (5) (2021) 1690.
[31] WHO, Action Framework for Developing and Implementing Public Food Procurement and Service Policies for a Healthy Diet, 2021.
[32] WHO, Inter-ministerial Meeting to Revitalize Health Promoting Schools in South-East Asia Region (Virtual); 12–14 October 2021, World Health Organization. Regional Office for South-East Asia, 2021.
[33] WHO, Nutrition Action in Schools: A Review of Evidence Related to the Nutrition-Friendly Schools Initiative, 2020.