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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

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ABSTRACT

The lockdowns resulting from the first wave of the coronavirus disease 2019 (COVID-19) pandemic impacted deeply on all life activities, including diet. We performed a systematic review to investigate changes in food intake, eating behaviors, and diet quality during lockdown as compared with before the lockdown. A literature search was performed using 3 electronic databases from inception until 13 June 2021. Observational studies evaluating changes in general populations during the COVID-19 pandemic lockdown were eligible. Of 1963 studies retrieved from the search strategy, 95 met inclusion criteria (85 in adults, 10 in children/adolescents), and the majority were of high quality (72.6%). Most of the studies were web-based surveys using convenience sampling, mainly focused on variations in the consumption of foods and eating behaviors during lockdown, whereas only 15 studies analyzed diet quality through dietary indices. On the basis of the definition of a healthful diet as reflected by a traditional Mediterranean diet, an increase in recommended foods such as fruit and vegetables, legumes, cereals, and olive oil was observed, although a sharp decrease in fish intake and an increase in dairy products were documented. Accordingly, a reduction in foods that should be eaten less frequently was reported—namely, red and processed meat. However, a higher consumption of unhealthy foods (e.g., snacks and sweets) was also observed. Results indicated improved diet quality in Europe, especially among Mediterranean countries, with the exception of France, while a switch to poor nutrient patterns was observed in Colombia and Saudi Arabia. Analyses of eating behaviors suggest an increase in food intake, number of daily meals, and snacking. In conclusion, changes in intake of major food groups, apart from fish intake, were in line with the definition of a traditional Mediterranean diet, indicating a consistent moderate improvement in dietary habits worldwide. This review protocol was registered at https://www.crd.york.ac.uk/prospero/ as CRD42020225292. Adv Nutr 2022;13:388–423.

Statement of Significance: This is the first systematic review to conduct a comprehensive analysis of changes in different aspects of nutrition during the COVID-19 nationwide lockdowns. The present study summarizes evidence from studies published until the first half of 2021.

Keywords: diet quality, dietary changes, eating behaviors, lockdown, confinement, COVID-19, pandemic

Introduction

The coronavirus disease 2019 (COVID-19), induced by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), is a severe respiratory infectious disease that broke out in China in December 2019, and rapidly spread around the world; hence, in March 2020, the WHO Emergency Committee declared a pandemic state (1).

Worldwide governments considered social isolation as the most successful way to limit the infection spread, so many countries enacted lockdown (also called confinement, stay-at-home, shelter in place, etc.) strategies, limiting access to only essential services in order to flatten the curve of new infections and to prevent the collapse of health care systems (2, 3).

Confinement measures included working from home, digital education, travel ban, and closure of nonessential shops and services, and all nonessential workers were invited to stay home.
The COVID-19 lockdown deeply changed lifestyles of communities, thus having considerable impact on physical and mental health, and on social and economic aspects (4).

Limited access to food due to restricted store opening hours, as well as reduced availability of goods and more time spent at home, could have had effects on food purchasing and preparation and as a result on diet quality (5). Moreover, boredom and feelings of anxiety, triggered by such an adverse scenario, could have impacted food choices, leading to irregular eating and more frequent snacking (6, 7).

Unhealthy diets and concurrent decline in physical activity could negatively affect health status, potentially leading to an increase in obesity and other risk factors (8), which, in turn, may raise vulnerability to complications of COVID-19 (9).

It is well recognized that the maintenance of healthy eating behaviors is fundamental to enhance health. In fact, a balanced nutritional pattern could boost the immune system (10) through both intake of anti-inflammatory nutrients (11) and consumption of food items fermented by gut microbiota providing metabolic compounds involved in homeostasis of the inflammation process (12). Therefore, it is crucial to understand whether the lockdown period may have had an impact on diet quality, and to what extent such modifications may have long-term effects on health at a population level.

To date, there have been several studies worldwide investigating the impact of lockdown resulting from the first wave of the COVID-19 pandemic on dietary changes, although results are mixed; also, the dietary assessment varies largely across studies and, most importantly, a comprehensive assessment of changes in diet quality as reflected by variations in validated dietary indexes is often lacking. A few available reviews of the literature (either systematic or scoping) (13–16) analyzing from 7 to 32 articles published in the year 2020 are concordant in indicating an increase in snacking, meal number, and home cooking, as well as a rise in fruit and vegetable intakes, although data on modification of other foods (e.g., alcohol intake) were conflicting.

Given the mounting evidence on the relation between lockdown and dietary modifications well after the year 2020 and the pivotal role of diet as a major health determinant, we conducted a systematic review of the literature examining the impact of lockdown caused by the COVID-19 pandemic on dietary habits compared with before the pandemic outbreak.

For this purpose, we considered studies that examined variations in 3 main research themes that pertain to diet—that is, 1) changes in food (i.e., foods or food groups) and beverage intake, 2) eating behaviors (e.g., snacking, amount of food eaten, home cooking), and 3) overall diet quality (i.e., assessed through the use of dietary indices).

**Methods**

This study was conducted according to the recommendations outlined in the Cochrane Handbook for Systematic Reviews of Interventions (17) and adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (18). The protocol was registered in PROSPERO at https://www.crd.york.ac.uk/prospero/ as CRD42020225292. Institutional review board approval was not required, as the study did not directly involve human participants.

**Search strategy**

Electronic databases (PubMed, Web of Science, Google Scholar) were searched to identify all reports regarding 3 main interrelated concepts: diet, COVID-19, and lockdown (Supplemental Table 1). A systematic literature search was performed from inception until 10 March 2021, followed by an updated search through 13 June 2021. The following terms were searched with the widest field restriction possible in PubMed and Web of science (i.e., all fields) and with restrictions to all-in-title in Google Scholar: (Diet OR Nutrition OR Food OR “Eating habits” OR “DIetary changes” OR “Dietary behaviour” OR “Mediterranean diet”) AND (Coronavirus OR “Covid” OR “SARS-CoV-2” OR “COVID-19”) AND (lockdown OR confinement OR “shelter in place” OR “stay at home” OR isolation OR “covid restrictions” OR quarantine). A more exhaustive search strategy list for each database is provided in Supplemental Table 2.

**Study selection**

Studies were eligible if they met the following inclusion criteria: 1) outcomes were changes in food and beverages consumption, eating behaviors, and overall diet quality; 2) subjects recruited were from general populations of adults and children; 3) exposure was nationwide lockdown resulting from the first wave of the COVID-19 outbreak as compared with before the lockdown; 4) observational cross-sectional, case-control, cohort, and longitudinal studies; and 5) English-language research articles. A detailed design is summed up in Supplemental Table 3, by following the PICOS (Population, Intervention, Comparison, Outcome, Study) format.

Exclusion criteria were as follows: 1) no alterations in eating (i.e., changes in food intake or eating behaviors or diet quality were reported; 2) dietary changes not examined during lockdowns; 3) special populations (e.g., subjects on special diets or with pre-existing disease/health conditions; pregnancy; university students); 4) randomized clinical trials, reviews, meta-analyses; and 5) articles not in English. Restrictions in terms of language were applied due to authors’ inability to translate non-English-language studies.
Search results from each database were initially exported to Mendeley®, provided by Elsevier, and duplicates were identified and discarded. Thereafter, records were manually screened for titles and abstracts, and nonconforming ones were excluded. Full-text articles were checked for eligibility criteria, and references of included studies were manually screened to obtain additional papers.

Data extraction and quality assessment
Two authors (CM and MB) screened and reviewed articles in line with inclusion criteria. From each study, the following information was extracted: name of first author and year of publication, country, recruitment period, sample size, age, data collection and study design, dietary assessment, main findings, and authors’ interpretation of main findings. Data were grouped according to the 3 main research themes (reported changes in food intake, eating behaviors, and diet quality) and analyzed for adults and children separately. Two authors (CM and MB) independently evaluated the methodological quality of the included studies, with disagreements being solved by discussion with a third investigator (SC). Due to heterogeneity in experimental designs of extracted data, it was not possible to perform meta-analysis.

The quality of included studies was evaluated by using the Joanna Briggs Institute (JBI) Critical Appraisal Checklists for Analytical Cross-Sectional Studies and Cohort Studies (19) (Supplemental Tables 4 and 5).

Results
Search results
The initial systematic search of databases identified 1963 potentially pertinent articles, and among them 252 were excluded since they were duplicates. After reviewing titles and abstracts, 1556 papers were further excluded since they were not related to changes in dietary habits during the COVID-19 lockdown. In this selection, papers aiming not to specifically investigate nutritional changes were considered whenever they described or evaluated alterations in lifestyle habits. After that, 155 full-text articles were reviewed and 60 were excluded according to the inclusion criteria. The full PRISMA record management flow diagram is shown in Figure 1.

Finally, 85 articles in adults and 10 in children/adolescents were selected for this systematic review. Subsequently, studies in adults were grouped into 3 main research themes, according to changes in the following outcomes: 1) consumption of food and beverages (Figure 2, Table 2), 2) eating behaviors (Figure 3, Table 3), and 3) overall diet quality as assessed by dietary indices (Table 4). For studies evaluating dietary changes in children/adolescents, an independent assessment was carried out (Table 5).

Studies were mostly carried out in Europe, with the highest number recorded in Italy (4, 20–30) and Spain (31–37) followed by Poland (38–43), France (44–48), the United Kingdom (49–53), Belgium (54, 55), Greece (56, 57), The Netherlands (58), Denmark (59), Croatia (60), Romania (61), Albania (62), Lithuania (63), Scotland (64), Cyprus (65), and Germany (66). Outside Europe, other surveys were conducted in Kuwait (67), the United Arab Emirates (68, 69), Saudi Arabia (70–73), Jordan (74, 75), Iraqi Kurdistan (76), the United States (77–80), Canada (81), Brazil (82–84), Mexico (85), Colombia (86), Chile (87), Ecuador (88), Uruguay (89), Peru (90), Zimbabwe (91), China (92–95), India (96, 97), Nepal (98), New Zealand (99), and Australia (100, 101). Other studies were conducted as international surveys (102–113). The length of nationwide lockdowns varied across countries, with the longest recorded in the United Kingdom (112 d) and Nepal (120 d) and the shortest in Kuwait and Ecuador (15 d), Iraqi Kurdistan and Cyprus (20 d), and the United Arab Emirates (22 d) (Table 1).

Due to pandemic status limitations, with difficulty in performing person-to-person questionnaires or interviews, all of the studies included data collected through online questionnaires or, on a few occasions, through telephone or web interviews (22, 23, 25, 31, 56).

Most of the studies were carried out during the first 3 mo of lockdown (March to May 2020), when containment measures were stricter worldwide. Otherwise, the recruitment period of some surveys lasted until September (23, 25, 113) (Table 1).

Concerning quality assessment, 26 studies out of 95 (20, 27, 30, 38, 40, 43, 51, 61, 62, 71–73, 75, 83, 84, 90, 91, 95, 97, 98, 100, 102, 104, 106, 112, 113) were considered of low quality (27.4%), having a JBI score <70% (Supplemental Tables 4 and 5).

Change in food and beverage intakes in adults
A total of 76 studies reported differences in consumption of foods and beverages mainly by asking participants to indicate whether their consumption of selected foods and beverages had changed during lockdown as compared with before, mostly in the form of eating less/more/the same of a given food or beverage, with some exceptions otherwise inquiring about changes in frequency of consumption (49, 51) or modifications in line with dietary recommendations (27) (Tables 1 and 2).

With regard to changes in food intake, increased consumption of fruit and vegetables was reported by 31 studies (20, 22, 25, 27, 29, 32, 33, 35, 45, 49, 52, 54, 60–63, 65, 71, 76, 83, 87, 89, 90, 92, 94–96, 103, 111, 113), whereas a decrease was found in 8 studies (59, 73, 77, 82, 86, 91, 99, 110). However, some (4, 26, 81) found an increase only in vegetable consumption, as opposed to a decrease in fruit intake, while a French study (44) found a decrease in fresh fruit and vegetable consumption but an increase in canned and frozen vegetables. Others found an increase (43) and a decrease (41, 42) only in fruit. Increases of fruit intake went from 15.2% to 73.5%, whereas increases in vegetables were in the range 11.9% to 52.0%.

Sharp changes were observed also for legumes, with 17 studies registering increased consumption from 10.9% to 21.9% (4, 25, 26, 33, 41, 42, 44, 45, 46, 60, 65, 76, 86, 89, 90, 95, 96, 111); in contrast, a reduction from 9.9% to 25.9% was
observed in only 4 of the included studies (22, 59, 82, 99). An increase in red and processed meat consumption from 20.0% to 51.1% was reported by 14 investigations (4, 22, 31, 33, 35, 38, 43, 45, 61, 62, 77, 95, 96, 113), whereas 17 studies pointed to a decreasing consumption from 6.7% to 24.4% (20, 23, 25, 26, 32, 41, 42, 44, 59, 60, 63, 65, 76, 78, 90, 110, 111). Olive oil was consistently found to be increased from 12.4% to 12.6% in all studies addressing this issue (25, 33, 60, 65, 111). As reported by 19 studies (4, 20, 22, 25, 29, 35, 41–43, 45, 62, 77, 81, 86, 89, 91, 110, 111), fish and seafood intakes significantly decreased from 9.4% to 31.3%; conversely, only 6 studies observed an increase (33, 45, 59, 65, 81, 95).

An increase from 7.7% to 51.0% was found for dairy product intake (e.g., yogurt, cheese) compared with pre-lockdown levels (4, 20, 22, 25, 35, 41–45, 62, 65, 76, 78, 81, 92, 95, 113), whereas 4 studies (33, 77, 91, 110) pointed to a decrease from 21.4% to 44.9%.

Studies investigating cereal intake (e.g., pasta and rice, bread, flour, grains) reported an increased consumption of grains (4, 22, 25, 29, 35, 41–43, 45, 62, 77, 81, 86, 89, 99), and a lower intake of whole-grain products (65, 77, 99). A positive change was found in water consumption, which increased from 3.0% to 70.0% in all studies investigating this issue (23, 25, 41–44, 62, 68, 77, 78, 86, 89, 104, 113).

Unhealthy foods, such as fast food, junk food, and processed food in general, including energy and sweetened drinks, were likely consumed less during the pandemic as compared with the usual intake in 14 studies (4, 32, 42, 56,
FIGURE 2  Percentages of high-quality and peer-reviewed observational studies from general adult populations reporting increased/decreased/unchanged consumption of food groups and beverages during the lockdown following the first wave of the COVID-19 outbreak as compared to before (corresponding number on the related bars). COVID-19, coronavirus disease 2019.

67, 68, 78, 89, 90, 96, 97, 104, 106, 111), although 33 studies found an increase (20–22, 26, 29, 31, 33–35, 40, 45, 47, 49, 50, 52, 54, 55, 58, 62, 65, 69, 71, 76, 77, 79, 82–84, 92, 95, 99, 102, 110). In addition, some investigations (23, 27, 38, 41, 43, 44, 59, 60, 63, 73, 86, 113) reported both an increase and a lower intake of unhealthy foods.

Reduced alcohol intake (12.1–57.3%) was reported by 17 studies (4, 20, 32, 35, 46, 55, 56, 60, 65, 76, 85, 96, 97, 98, 102, 106, 111), whereas 25 investigations observed an increase (14.6–81.2%) (22, 26, 31, 33, 34, 38–45, 47, 52, 59, 64, 66, 77, 80, 82, 91, 99, 110, 112).

Results were unchanged in a narrower analysis restricted to 51 high-quality-assessment studies. Indeed, an increase in recommended foods such as fruit and vegetables, legumes, and cereals was observed by 64%, 68%, and 74% of the studies, respectively, along with a sharp decrease in fish (70%). For foods that should be eaten less frequently, studies reported a decrease in red and processed meat (56.0%) while suggesting higher consumption of dairy products (76%) and unhealthy foods (59%) (Figure 2). Analyses of changes in food-group intakes by geographic areas revealed some differences between countries. Specifically, fruit and vegetable intake was found to be increased worldwide, although increases were more pronounced in European and Asian populations as compared with North American settings (Supplemental Figures 1–4). Unhealthy food consumption was higher during lockdown worldwide, with the exception of South America, where decreased, unchanged, and increased options were equally distributed. The greatest increase in alcoholic beverages was observed among Europeans and North Americans, whereas Asian studies reported exclusively a decrease. Red meat intake was sharply lowered in Europe but not in Asian and South American countries, whereas fish and seafood intake was consistently found to be reduced. Last, consumption of dairy products increased markedly in Europe and North America while being less evident in Asian countries.

Change in eating behaviors in adults

Fifty-nine studies analyzed changes in eating behaviors, as reflected by amount of food eaten, home cooking, snacking, and consumption of take-away or delivered food (Table 3). The majority of study respondents reported to have increased the number of meals per day (23, 25, 34, 38, 49, 65, 68, 102, 104) and amount of food eaten (4, 20, 21, 24, 38–42, 49–51, 53, 61, 63, 70, 72, 78, 86, 87, 89, 100, 102, 106, 109). Additionally, during lockdown, home cooking increased (4, 23–25, 32–34, 39, 44, 45, 52, 59–61, 63, 67–70, 76, 86, 87, 99, 103, 104, 109, 111), home-cooked food was eaten more frequently (4, 22, 33, 41, 42, 68–70, 76, 85, 89, 99, 104, 111), and concurrent reductions in eating outside (32, 38, 39, 44, 46, 49, 50, 59, 60, 63, 67, 72, 78, 86, 102, 111, 112).

Results remained substantially the same when analysis was limited to 42 high-quality studies (Figure 3), confirming an increase in food intake (81%), number of daily meals (67%) and snacking (87%).

Analysis by geographic areas highlighted substantial similarities across countries worldwide for changes in eating behaviors, although the increase in the number of daily meals was less marked in Asian studies as compared with others (Supplemental Figures 5–8).
### TABLE 1  Descriptive characteristics of included observational studies from general populations analyzing changes in food intake, eating behaviors, and diet quality during nationwide lockdowns resulting from the first wave of the COVID-19 pandemic†

| First author, year (ref) | Country | Nationwide lockdown timeline (length in days) | Survey period | Study design | Data collection | Dietary assessment | Sample size | Age (mean ± SD), y |
|--------------------------|---------|-----------------------------------------------|---------------|-------------|----------------|-------------------|-------------|------------------|
| Aguilar-Martínez et al., 2021 (37) | Spain | March 14/May 9, 2020 (56) | June–July 2020 | Cross-sectional/retrospective | Web-based survey on DESK cohort participants | Changes by food quantity and frequency of eating behaviors | 303 | 16.4 ± 1.11 |
| López-Moreno et al., 2020 (34) | Spain | March 14/May 9, 2020 (56) | May 28–June 21, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 675 | 39.1 ± 12.9 |
| Medrano et al., 2020 (36) | Spain | March 14/May 9, 2020 (56) | September–December 2019/March–April 2020 | Longitudinal | Web-based survey | KIDMED | 106 | 12.0 ± 2.6 |
| Rodríguez-Pérez et al., 2020 (32) | Spain | March 14/May 9, 2020 (56) | From March 20, 2020, for 3 wk | Cross-sectional/retrospective | Web-based survey on convenience sample | Daily/weekly frequency before and during lockdown MEDAS (score 0–14) | 7514 | ≥18 |
| Romeo-Arroyo et al., 2020 (35) | Spain | March 14/May 9, 2020 (56) | Last week of April 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 600 | 42.6 ± 12.2 |
| Sánchez-Sánchez et al., 2020 (33) | Spain | March 14/May 9, 2020 (56) | May 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Daily/weekly frequency before and during lockdown MEDAS (score 0–14) | 1065 | 38.7 ± 12.4 |
| Sánchez et al., 2021 (31) | Spain | March 14/May 9, 2020 (56) | May 26–June 20, 2020 | Cross-sectional/retrospective | Computer-assisted telephone interviews on a representative sample | Eating more/less/the same | 1000 | 51 ± 18 |
| Bonaccio et al., 2021 (23) | Italy | March 9/May 18, 2020 (70) | May–September 2020 | Cross-sectional/retrospective | Telephone-based survey (Moli-LOCK cohort) and web-based survey on convenience sample (ALTRISCOVID-19 cohort) | Eating more/less/the same | 2992 | 57.9 ± 15.3 |

(Continued)
| First author, year (ref) | Country | Nationwide lockdown timeline (length in days) | Survey period | Study design | Data collection | Dietary assessment | Sample size | Age (mean ± SD), y |
|---------------------------|---------|-----------------------------------------------|---------------|--------------|----------------|-------------------|-------------|-------------------|
| Cancello et al., 2020 (21) | Italy   | March 9/May 18, 2020 (70)                     | April 15–May 4, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 490 | ≥18 |
| Cicero et al., 2021 (22)  | Italy   | March 9/May 18, 2020 (70)                     | February-April 2020 and after the quarantine | Cohort study; longitudinal | Telephone-based survey | Daily/weekly frequency before and during lockdown; DQI | 359 | 646 ± 13.3 |
| Di Renzo et al., 2020 (4) | Italy   | March 9/May 18, 2020 (70)                     | April 5–24, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 3533 | 40.0 ± 13.5 |
| Ferrante et al., 2021 (26) | Italy   | March 9/May 18, 2020 (70)                     | April 21–June 7, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 7847 | 48.6 ± 13.9 |
| Maffoni et al., 2021 (27) | Italy   | March 9/May 18, 2020 (70)                     | April 30–May 10, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Dietary recommendations | 1304 | ≥18 |
| Mastorci et al., 2021 (28) | Italy   | March 9/May 18, 2020 (70)                     | September-October 2019/April 2020 | Longitudinal | Web-based survey | KIDMED | 1289 | 12.5 ± 1.2 |
| Prete et al., 2021 (29)   | Italy   | March 9/May 18, 2020 (70)                     | May 9–3, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 604 | 298 ± 10.4 |
| Ruggiero et al., 2021 (23) | Italy   | March 9/May 18, 2020 (70)                     | May–September 2020 | Cross-sectional/retrospective | Telephone-based survey (Moli-LOCK cohort) and web-based survey on convenience sample (ALTRISCovid-19 cohort) | Eating more/less/the same | 3161 | 577 ± 15.4 |
| Scacchi et al., 2021 (24) | Italy   | March 9/May 18, 2020 (70)                     | May 6–31, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 1865 | Median 29 (IQR 16.0) |
| Scarmozzino et al., 2020 (20) | Italy | March 9/May 18, 2020 (70)                     | April 3–15, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 1932 | NA |
| Segre et al., 2021 (30)   | Italy   | March 9/May 18, 2020 (70)                     | May 18–June 7, 2020 | Cross-sectional/retrospective | Online interview | Eating more/less/the same | 82 | 6–14 |

(Continued)
### Table 1 (Continued)

| First author, year (ref) | Country | Nationwide lockdown timeline (length in days) | Survey period | Study design | Data collection | Dietary assessment | Sample size | Age (mean ± SD), y |
|--------------------------|---------|---------------------------------------------|---------------|-------------|----------------|-------------------|-------------|-------------------|
| Pfeifer et al., 2021 (60) | Croatia | March 18/April 19, 2020 (32) | April 7–May 4, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Daily/weekly frequency before and during lockdown MEDAS (score 0–14) | 4281 | ≥18 |
| Mittelu et al., 2021 (61) | Romania | March 25/May 12, 2020 (48) | July 8–26, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 805 | ≥20 |
| Tiroka et al., 2021 (62)  | Albania | March 13/June 1, 2020 (80) | March–May 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 325 | NA |
| Androutsos et al., 2021 (57) | Greece | March 23/May 4, 2020 (42) | April 30–May 24, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Daily/weekly frequency before and during lockdown | 397 | 7.8 ± 4.1 |
| Tsigkas et al., 2021 (56) | Greece | March 23/May 4, 2020 (42) | April 13–30, 2020 | Cross-sectional/retrospective | Telephone-based survey | Eating more/less/the same | 1014 | ≥35 |
| Kolokotroni et al., 2021 (65) | Cyprus | March 24/April 13, 2020 (20) | April 10–May 12, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Daily/weekly frequency before and during lockdown MEDAS (score 0–14) | 745 | 39 (median) |
| Deschasaux-Tanguy et al., 2020 (44) | France | March 17/May 11, 2020 (55) | April–May 2020 | Cohort study; longitudinal | Web-based survey | Web-based 24h dietary records; AHEI-2010 score and UPF (% food weight) | 9372 | 52.1 ± 16.6 |
| Marty et al., 2020 (45) | France | March 17/May 11, 2020 (55) | End of April 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Daily/weekly frequency and amount before and during lockdown sPINS-GS2 (score –17 to 11.5) to assess compliance to French dietary recommendations | 938 | 38.7 ± 11.6 |
| Constant et al., 2020 (46) | France | March 17/May 11, 2020 (55) | April 8–20, 2020 | Cross-sectional/retrospective | Web-based survey among panelists from the Arcade Research Institute | Eating more/less/the same | 4005 | ≥18 |
| First author, year (ref) | Country | Nationwide lockdown timeline (length in days) | Survey period | Study design | Data collection | Dietary assessment | Sample size | Age (mean ± SD), y |
|--------------------------|---------|-----------------------------------------------|---------------|-------------|----------------|-------------------|-------------|-------------------|
| Philippe et al., 2021 (48) | France | March 17/May 11, 2020 (55) | April 30–May 10, 2020 | Retrospective | Web-based survey among panelists from a French agency | Eating more/less/the same | 498 | 73 ± 2.2 |
| Rolland et al., 2020 (47) | France | March 17/May 11, 2020 (55) | March 25–30, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 11,391 | ≥16 |
| Steffen et al., 2021 (66) | Germany | March 22/April 20 to May 11, 2020 (29 to 50) | March–April 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 2067 | 25.6 ± 10.6 |
| Drieskens et al., 2021 (55) | Belgium | March 18/May 4, 2020 (47) | April 16–23, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 28,029 | ≥18 |
| Vandevijvere et al., 2020 (54) | Belgium | March 18/May 4, 2020 (47) | March–May 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 8640 | ≥18 |
| Blaszczyk-Bebenek et al., 2020 (38) | Poland | March 13/April 11, 2020 (29) | April–May 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Daily/weekly frequency before and during lockdown | 312 | 41.1 ± 13.0 |
| Dobrowolski et al., 2021 (40) | Poland | March 13/April 11, 2020 (29) | NA | Cross-sectional/retrospective | Computer-assisted web interview on convenience sample | Eating more/less/the same | 183 | 33 ± 11 |
| Drywień et al., 2021 (41) | Poland | March 13/April 11, 2020 (29) | April–May 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 1769 women | ≥18 |
| Górecka et al., 2020 (42) | Poland | March 13/April 11, 2020 (29) | April 30–May 23, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 2381 | ≥18 |
| Kowalczyk et al., 2021 (43) | Poland | March 13/April 11, 2020 (29) | March 20–May 30, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 926 | ≥18 |
| Sidor et al., 2020 (39) | Poland | March 13/April 11, 2020 (29) | April 17–May 1, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 1097 | 27.7 ± 9.0 |
| Giacalone et al., 2020 (59) | Denmark | March 12/April 13, 2020 (33) | April 24–May 5, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 2462 | ≥18 |
| First author, year (ref) | Country | Nationwide lockdown timeline (length in days) | Survey period | Study design | Data collection | Dietary assessment | Sample size | Age (mean ± SD), y |
|--------------------------|---------|---------------------------------------------|--------------|-------------|----------------|-------------------|-------------|------------------|
| Kriaucioniene et al., 2020 (63) | Lithuania | March 16/June 18, 2020 (94) | From April 14, 2020 for 2 wk | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 2447 | ≥18 |
| Poelman et al., 2020 (58) | The Netherlands | March 15/April 6, 2020 (22) | April 22–28, 2020 | Cross-sectional/retrospective | Web-based survey on a representative sample of adults | Eating more/less/the same | 1030 | 49.9 ± 17.0 |
| Buckland et al., 2020 (49) | United Kingdom | March 23/July 13, 2020 (98 to 112) | May 15–June 27, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Changes by frequency of intake | 588 | 33.4 ± 12.6 |
| Coulthard et al., 2021 (52) | United Kingdom | March 23/July 13, 2020 (98 to 112) | April 22–May 22, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 620 | 39.9 ± 13.9 |
| Herle et al., 2021 (53) | United Kingdom | March 23/July 13, 2020 (98 to 112) | March 28–June 4, 2020 | Longitudinal | Web-based survey on convenience sample | Eating more/less/the same | 22,374 | ≥18 |
| Robinson et al., 2020 (51) | United Kingdom | March 23/July 13, 2020 (98 to 112) | April 19–22, 2020 | Cross-sectional/retrospective | Web-based survey among Prolific Researcher panelists | Changes by frequency of intake | 723 | 30.7 ± 96 |
| Robinson et al., 2020 (50) | United Kingdom | March 23/July 13, 2020 (98 to 112) | April 28–May 22, 2020 | Cross-sectional/retrospective | Web-based survey among Prolific Researcher panelists | Changes by frequency of intake | 2002 | 34.7 ± 12.3 |
| Ingram et al., 2020 (64) | Scotland | March 23/June 29, 2020 (98) | March–May 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample among Prolific Academic users | Eating more/less/the same | 399 | 32.4 ± 11.4 |
| Bin Zarah et al., 2020 (77) | USA | March–June, 2020 (20 to 89) | April–June 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 3133 | ≥18 |
| Cummings et al., 2021 (79) | USA | March–June, 2020 (20 to 89) | March 2020 | Comparison with a similar cohort recruited in February 2019 | Web-based survey on convenience sample | Palatable Eating Motives Scale; National Cancer Institute's Dietary Screener Questionnaire; Modified Yale Food Addiction Scale 2.0 | 868 | ≥18 |
| First author, year (ref) | Country | Nationwide lockdown timeline (length in days) | Survey period | Study design | Data collection | Dietary assessment | Sample size | Age (mean ± SD), y |
|--------------------------|---------|-----------------------------------------------|---------------|-------------|----------------|-------------------|-------------|-------------------|
| Chenarides et al., 2020 (78) | USA | March–June, 2020 (to 89) | May 13–30, 2020 | Cross-sectional/retrospective | Web-based survey | Eating more/less/the same | 861 | 53 ± 18 |
| Zhang et al., 2021 (80) | USA | March–June, 2020 (to 89) | May/June 2020 | Cross-sectional/retrospective | Web-based survey | Eating more/less/the same | 1276 | 45 ± 17 |
| Lamarche et al., 2021 (81) | Canada | March 17/May 18, 2020 (58 to 61) | June 2019 and February 2020 (before lockdown) | Open cohort study; longitudinal | Web-based survey | Web-based 24-h dietary recall HEI-2015 (score 0–100) | 853 | ≥18 |
| Christopho et al., 2021 (83) | Brazil | March 17/May 20, 2020 (21 to 47) | May 5–17, 2020 | Cross-sectional/retrospective | Web-based survey | Eating more/less/the same | 1874 | ≥18 |
| Malta et al., 2020 (82) | Brazil | March 17/May 20, 2020 (21 to 47) | April 24–May 24, 2020 | Cross-sectional/retrospective | Web-based survey | Daily/weekly frequency before and during lockdown; self-rated changes for alcohol consumption | 45,161 | ≥18 |
| Tebar et al., 2021 (84) | Brazil | March 17/May 20, 2020 (21 to 47) | May 5–17, 2020 | Cross-sectional/retrospective | Web-based survey | Eating more/less/the same | 1897 | 37.9 ± 13.3 |
| Martínez-Vázquez et al., 2021 (85) | Mexico | March 23/June 1, 2020 (70) | April 13–May 16, 2020 | Cross-sectional/retrospective | Web-based survey | Daily/weekly frequency before and during lockdown | 8289 | ≥18 |
| Pertuz-Cruz et al., 2021 (86) | Colombia | March 25/June 30, 2020 (97) | April 6–May 22, 2020 | Cross-sectional/retrospective | Web-based survey | Daily/weekly frequency before and during lockdown | 2745 | ≥18 |
| Ramos-Padilla et al., 2021 (88) | Ecuador | March 16–31, 2020 (15) | June–July 2020 | Cross-sectional/retrospective | Web-based survey | Eating more/less/the same | 9522 | 18–69 |

(Continued)
| First author, year (ref) | Country | Nationwide lockdown timeline (length in days) | Survey period | Study design | Data collection | Dietary assessment | Sample size | Age (mean ± SD), y |
|--------------------------|---------|-----------------------------------------------|---------------|--------------|----------------|-------------------|-------------|-------------------|
| Ares et al., 2021 (89)  | Uruguay | No restrictions                               | March 2020    | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 1725        | ≥18               |
| Huancahuire-Vega et al., 2020 (90) | Peru | March 16/June 30, 2020 (106)                   | July 16–August 31, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Daily/weekly frequency before and during lockdown | 1176        | ≥18               |
| Reyes-Olavarria et al., 2020 (87) | Chile | Partial lockdowns                              | May–June 2020  | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 700         | Median 31 (18–62) |
| Jia et al., 2020 (93)   | China   | January 23/April 8, 2020 (76)                  | May 9–12, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Self-recall food consumption before and during lockdown | 10,082      | 19.8 ± 2.3 (15–28) |
| Wang et al., 2020 (92)  | China   | January 23/April 8, 2020 (76)                  | March–April 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Weekly frequency and amount before and during lockdown | 2289        | 27.8 ± 12.0       |
| Yang et al., 2021 (94)  | China   | January 23/April 8, 2020 (76)                  | February 23–March 4, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 2702        | 37.3 ± 12.0       |
| Zhu et al., 2021 (95)   | China   | January 23/April 8, 2020 (76)                  | March 29–April 5, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 889         | 31.8 ± 11.4       |
| Chopra et al., 2020 (96) | India | March 25/June 7, 2020 (74)                     | August 15–30, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Daily/weekly frequency before and during lockdown | 995         | 3.3 ± 14.5        |
| Singh et al., 2021 (97) | India   | March 25/June 7, 2020 (74)                     | May 11–20, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 1008        | 24 (median)       |
| Shrestha et al., 2020 (98) | Nepal | March 24/July 21, 2020 (120)                   | March 30/July 31, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 667         | ≥18               |
| Husain et al., 2020 (67) | Kuwait  | March 14–29, 2020 (15)                         | March–April 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Daily/weekly frequency before and during lockdown | 415         | 38.5 ± 12.7       |
| Alfawaz et al., 2021 (73) | Saudi Arabia | March 9/June 21, 2020 (84 to 104)           | May 11–June 6, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Daily/weekly frequency before and during lockdown | 1965        | 35.2 ± 13.1       |
| First author, year (ref) | Country                     | Nationwide lockdown timeline (length in days) | Survey period          | Study design                        | Data collection                                      | Dietary assessment                                      | Sample size | Age (mean ± SD), y |
|--------------------------|-----------------------------|-----------------------------------------------|------------------------|-------------------------------------|------------------------------------------------------|----------------------------------------------------------|-------------|-------------------|
| Alhusseini et al., 2020  | Saudi Arabia                | March 9/June 21, 2020 (84 to 104)             | May 5–15, 2020         | Cross-sectional/retrospective       | Web-based survey on convenience sample               | Daily/weekly frequency; Food Quality score (score 5–25) | 2706        | ≥18               |
| Aljohani, 2020           | Saudi Arabia                | March 9/June 21, 2020 (84 to 104)             | April–June 2020        | Cross-sectional/retrospective       | Web-based survey on convenience sample               | Eating more/less/the same                               | 782         | ≥16               |
| Mumena, 2020             | Saudi Arabia                | March 9/June 21, 2020 (84 to 104)             | April 13–22, 2020      | Cross-sectional/retrospective       | Web-based survey on convenience sample               | Daily/weekly frequency before and during curfew        | 879         | 35.8 ± 12.1       |
| Radwan et al., 2020      | United Arab Emirates        | March 26/April 17, 2020 (22)                  | May 5–18, 2020         | Cross-sectional/retrospective       | Web-based survey on convenience sample               | Eating more/less/the same                               | 2060        | ≥18               |
| Cheikh Ismail et al., 2020| United Arab Emirates       | March 26/April 17, 2020 (22)                  | April–May 2020         | Cross-sectional/retrospective       | Web-based survey on convenience sample               | Daily/weekly frequency before and during lockdown      | 1012        | ≥18               |
| Al-Domi et al., 2021     | Jordan                      | March 18/April 30, 2020 (43)                  | March and April 2020   | Cross-sectional/retrospective       | Web-based survey on convenience sample               | Self-rated                                              | 4473        | ≥18               |
| Al Hourani et al., 2021  | Jordan                      | March 18/April 30, 2020 (43)                  | June 15–30, 2020       | Cross-sectional/retrospective       | Web-based survey on convenience sample               | Daily/weekly frequency before and during lockdown      | 447         | 6–17              |
| Galali, 2021             | Iraqi Kurdistan             | March 22/April 11, 2020 (20)                  | June 1–14, 2020        | Cross-sectional/retrospective       | Web-based survey on convenience sample               | Eating more/less/the same                               | 2137        | NA                |
| Matsungo et al., 2020    | Zimbabwe                    | March 30/May 2, 2020 (33)                     | May 11–25, 2020        | Cross-sectional/retrospective       | Web-based survey on convenience sample               | Eating more/less/the same                               | 507         | 31–40             |
| Curtis et al., 2021      | Australia                   | March 23/May 15, 2020 (52)                    | February 2020/April 2020| Cohort study/longitudinal           | Web-based survey                                     | Dietary Questionnaire for Epidemiological Studies       | 64          | 41.3 ± 5.8        |
| Phillipou et al., 2020   | Australia                   | March 23/May 15, 2020 (52)                    | From April 1, 2020 for 1 wk | Cross-sectional/retrospective       | Web-based survey on convenience sample               | Eating more/less/the same                               | 5289        | 40.6 ± 13.7       |


| First author, year (ref) | Country | Nationwide lockdown timeline (length in days) | Survey period | Study design | Data collection | Dietary assessment | Sample size | Age (mean ± SD), y |
|--------------------------|---------|-----------------------------------------------|---------------|--------------|-----------------|-------------------|-------------|------------------|
| Gerritsen et al., 2020 (99) | New Zealand | March 26/May 14, 2020 (49) | April 24–May 13, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Daily/weekly frequency before and during lockdown | 3028 | 44.3 ± 14.0 |
| Abouzid et al., 2021 (113) | Middle East and North Africa (MENA) region | March–June, 2020 (varying by regions) | August–September 4, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Daily/weekly frequency before and during lockdown | 5896 | ≥18 |
| Ammar et al., 2020 (102) | Europe, North-Africa, Western Asia, and the Americas | Varying by country | April 6–11, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Dietary behaviours before and during lockdown by the use of the SDBQ-L (score 0–15; the highest the worst) | 1047 | ≥18 |
| Bahat et al., 2021 (108) | Saudi Arabia, UK, and Turkey | Varying by country | NA | Cross-sectional/retrospective | Web-based survey on convenience sample | Self-rated | 330 | 4–7 |
| Cavagnari et al., 2021 (107) | Spain and 11 Latin American countries | Varying by country | April 15–May 4, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 10,552 | Median 33 (18–86) |
| Cheikh Ismail et al., 2020 (104) | Middle East and North Africa (MENA) region | March–June, 2020 (varying by regions) | April 15–29, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Daily/weekly frequency before and during lockdown | 2970 | ≥18 |
| Dou et al., 2021 (109) | China and USA | Varying by country | April 17–27, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 1547 in the USA; 1732 in China | Median 41 (29–57) (USA) |
| Janssen et al., 2021 (110) | Denmark, Germany, and Slovenia | Varying by country | April 22–May 6, 2020 | Cross-sectional/retrospective | Web-based survey among consumer panel agencies with quota sampling | Daily/weekly frequency before and during lockdown | 2680 | 54.9 ± 14.1 (Denmark) |
| Molina-Montes et al., 2021 (111) | 16 European countries | Varying by country | March 20–May 5, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Daily/weekly frequency before and during lockdown MEDAS (score 0–14) | 36,185 | ≥18 |
| Papandreou et al., 2020 (112) | Spain, Greece | Spain: March 14/May 9, 2020 (56) Greece: March 23/May 4, 2020 (42) | April–May 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 1002 (Spain) 839 (Greece) | 46.1 ± 13.3 (Spain) 42.4 ± 11.7 (Greece) |

(Diary changes during COVID-19 lockdown 401 (Continued)
| First author, year (ref) | Country | Nationwide lockdown timeline (length in days) | Survey period | Study design | Data collection | Dietary assessment | Sample size | Age (mean ± SD), y |
|--------------------------|---------|---------------------------------------------|---------------|-------------|----------------|-----------------|-------------|-------------------|
| Pišot et al., 2020 (106) | Bosnia and Herzegovina, Croatia, Greece, Kosovo, Italy, Serbia, Slovakia, Slovenia, and Spain | Varying by country | April 15–May 3, 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Eating more/less/the same | 4108 | 32.0 ± 13.2 |
| Ruiz-Roso et al., 2020 (105) | Italy, Spain, Brazil, Chile, Colombia | Varying by country | April-May 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Self-recall food consumption before and during lockdown by using a modified version of the National School Health Survey—PeNSE questionnaire | 820 | 10–19 |
| Murphy et al., 2020 (103) | New Zealand, USA, Great Britain, and the Island of Ireland | Varying by country | May-June 2020 | Cross-sectional/retrospective | Web-based survey on convenience sample | Daily/weekly frequency and portions before and during lockdown | 2360 | ≥18 |

1 AHEI-2010, Alternate Healthy Eating Index–2010 score; ALTRISCVID-19, Analysis of Long Term Risk of COVID-19; COVID-19, coronavirus disease 2019; DQI, Dietary Quality Index; HEI-2015, Healthy Eating Index-2015; KIDMED, Mediterranean Diet Quality Index for children and teenagers; MEDAS, PREDMÉD (PREvención con Dieta MEDiterránea) Mediterranean Diet Adherence Screener; NA, not available; ref, reference; SDBQ-L, Short Diet Behaviours Questionnaire for Lockdowns; sPNNS-GS2, Simplified Programme National Nutrition Santé—guidelines score 2; UPF, ultra-processed food.
2 Argentina, Chile, Colombia, Costa Rica, Ecuador, Guatemala, Mexico, Peru, Paraguay, Panama, and Uruguay.
3 Bosnia and Herzegovina, Croatia, Denmark, Germany, Greece, Ireland, Italy, Lithuania, Montenegro, North Macedonia, Poland, Portugal, Serbia, Slovenia, Spain, and Turkey.
### Main findings of included observational studies from general adult populations evaluating changes in consumption of foods and beverages during the lockdown resulting from the first wave of the COVID-19 outbreak

| First author, year (ref) | Country | Increased | Decreased | Authors’ interpretation |
|--------------------------|---------|-----------|-----------|-------------------------|
| European studies         |         |           |           |                         |
| Sánchez-Sánchez et al., 2020 (33) | Spain | Olive oil, vegetables, fruits, red and processed meat, butter, margarine and cream, carbonated/sugary beverages, alcoholic drinks and wine, legumes, fish or seafood, industrial bakery, nuts, sofrito | Preference for white meat | Despite an increase in Mediterranean diet adherence, the consumption of “unhealthy” food also increased |
| Sánchez et al., 2021 (31) | Spain | Sugar-sweetened and alcoholic beverages, and other snacks (44.4%); bakery products (46.2%); red meat (20.4%) | — | No overarching interpretation provided |
| Rodríguez-Pérez et al., 2020 (32) | Spain | — | Alcohol (57.3%), fried food (20.3%), fast food (34.9%) | An improvement in dietary behaviors was observed |
| Romeo-Arroyo et al., 2020 (35) | Spain | Fruit, vegetables, sweets, milk and dairy products, meat and processed meat, pasta, and bread | Fish (33%), alcoholic beverages | No overarching interpretation provided |
| López-Moreno et al., 2020 (34) | Spain | Fast food (25.6%), fresh food (55.7%), alcoholic beverages (18.3%) | — | Mixed effects |
| Bonaccio et al., 2021 (23) | Italy | Pizza (31.2%), biscuits (18%), chocolate (18.6%), bread substitutes (11.8%), fruit yogurt (7.7%), water (17.2%) | Breakfast cereals, cereal bars (5.6%), sweet packaged snacks (12.7%), ready-to-heat potatoes and potato croquettes (9.9%), packaged bread (10.9%), fruit drinks (e.g., nectars) (7.9%), savory packaged snacks (12.5%), fish nuggets and sticks (9.4%), reconstituted meat products (11.1%), ready-to-heat vegetables (11.4%), soft drinks (12.3%), croissants (4.2%), instant sauces (11.4%), plant-based meat substitutes (10.2%), plant-based cheese substitutes (10.4%) | About 40% of our population switched to unfavorable eating as reflected by increased UPF intake |
| Cancello et al., 2020 (21) | Italy | Snack/appetizers | — | No overarching interpretation provided |
| Cicer et al., 2021 (22) | Italy | Bread and bread-like products, pasta, rice, vegetables, fruit, milk and yogurt, simple sugars and sweets, low-fat meat, cured meats, cheeses, eggs, healthy vegetable oils, mixed seed oils, nuts, coffee, alcoholic drinks, dietary supplements (19.2%) | Fish, mussels and shellfish, legumes | A trend towards decreasing diet quality |

(Continued)
## TABLE 2 (Continued)

| First author, year (ref) | Country | Increased | Decreased | Authors’ interpretation |
|--------------------------|---------|-----------|-----------|-------------------------|
| Di Renzo et al., 2020 (4) | Italy   | Cereals, legumes, red and white meat, fresh vegetables, dairy products, eggs, hot beverages | Fresh fish, fresh fruit, packaging sweets and baked products, baked products, alcohol, junk food (29.8%) | No overarching interpretation provided |
| Ferrante et al., 2021 (26) | Italy   | Sweets (45.1%), alcohol (17.3%), vegetables (40.3%), legumes (21.9%) whole grains (15.5%) | Processed meat (24.4%) | A meaningful proportion of respondents reported a worsening of eating habits, especially among women |
| Maffoni et al., 2021 (27) | Italy   | Fruit and vegetables, sweet/desserts | Water, sandwich/pizza | No overarching interpretation provided |
| Prete et al., 2021 (29) | Italy   | Sweets, cakes and pastry products (51%), bread/pasta/rice (30%), fresh fruit (28%), vegetables (27%) | Dried fruit (73%) | Prolonged lockdown promotes unhealthy lifestyle changes |
| Ruggiero et al., 2021 (25) | Italy   | Fresh vegetables (26.1%), cereals (25.7) fresh fruits (22.8), olive oil (12.6%) legumes (14.9%), white meat (15.1%), soft (12.5%) and hard cheese (10.7%), water (17.9%) | Fresh/frozen fish (23.2%), reconstituted meat products (6.7%) | Higher intake of foods characterizing a Mediterranean dietary pattern, healthier lifestyle and more sustainable food choices |
| Scarmozzino et al., 2020 (20) | Italy   | Fresh fruit and vegetables (21.2%), sweet food (42.5%), salty snacks (23.5%), milk/yogurt (14.3%), cheese (13.3%), coffee, tea, infusions (29.8%) | Red and processed meat (14.9%), fresh or canned fish (13.7%), alcohol (36.8%) | No overarching interpretation provided |
| Pfeifer et al., 2021 (60) | Croatia | Olive oil (12.4%), vegetables (21.2%), fruit (21.7%), legumes (10.9%), commercial pastries (21.5%), homemade pastries (33.5%) | Red meat (21.9%), soft drinks (25.6%), fish (15.2%), alcohol (27.7%), fast food (54.2%), fried foods (24.1%) | No overarching interpretation provided |
| Mittelbu et al., 2021 (61) | Romania | Vegetables and fruit (34.2%), meat and meat products (27.1%) | — | Positive changes reflected by increases in homemade food, fruit and vegetables |
| Troka et al., 2021 (62) | Albania | Bread (52%), dairy (51%), fruit (73.5%), vegetables (52%), meat (51.1%), sweets (56%), water (70%), homemade baked sweets (65.5%) | — | No overarching interpretation provided |
| Tsigkas et al., 2021 (56) | Greece  | — | Alcohol (34.3%), junk food (25.5%), snack (18.8%), salt (10.3%) | Significant lifestyle changes |
| Kolokotroni et al., 2021 (65) | Cyprus  | Fruit, vegetables, olive oil, butter, margarine, or cream, sweet beverages, legumes, fish, milk, yogurt, or cheese, commercial sweets and pastries, nuts, sofrito, caffeinated drinks, infusions/herbal teas | Red meat, whole cereals, alcohol | Though participants reported eating more, their quality of diet did not seem to change |
| First author, year (ref) | Country | Increased | Decreased | Authors' interpretation |
|--------------------------|---------|-----------|-----------|------------------------|
| Deschasaux-Tanguy et al., 2020 (44) | France | Canned vegetables (14.2%), frozen vegetables (14.3%), potatoes (15.3%), legumes (14.5%), cheese (17.8%), sweets and chocolate (21.7%), biscuits and cakes (20.4%), tap water (13%), alcohol (15.4%), tea and herbal tea (19.5%) | Fresh fruit (17.2%), fresh vegetables (17.7%), fish or shellfish (31.3%), fresh red meat (22.4%), sandwiches, pizza and savory pies (17.4%) | The lockdown led, in a substantial part of the population, to unhealthy nutritional behaviors |
| Marty et al., 2020 (45) | France | Fruits and vegetables, pulses, whole-grain food, dairy products, fish and seafood, processed meat, sugary food, sugary beverages, alcohol, salt | — | Decrease in the nutritional quality of diet on average, which could be partly explained by changes in food choice motives |
| Constant et al., 2020 (46) | France | — | Alcohol (21.1%) | Less than 4 in 10 respondents reported healthy changes over the same period, mostly in relation to better eating habits |
| Rolland et al., 2020 (47) | France | Caloric/salty food (28.3%), alcohol (15.4%) | — | Widespread increases in addiction-related habits |
| Steffen et al., 2021 (66) | Germany | — | Alcohol (40.2%) | Alcohol consumption was altered in an age-dependent manner |
| Drieskens et al., 2021 (55) | Belgium | Sweet or salty snacks (33.2%), sugared-sweetened beverages (8.2%) | Alcohol (17.7%) | No overarching interpretation provided |
| Vandevijvere et al., 2020 (54) | Belgium | Fruit and vegetables (15.2% and 11.9%), sweet and salty snacks (33.4%), sugared soft drinks (8.8%) | — | No overarching interpretation provided |
| Błaszczyk-Bębenek et al., 2020 (38) | Poland | Salty snacks (31.4%), eggs, potatoes, sweets, canned meat, alcohol | Fast food, instant soups, energy drinks | Nutrition behavior did not change during lockdown, nor did it increase the proportion of healthy products in the diet |
| Dobrowolski et al., 2021 (40) | Poland | Sweetened and confectionery products (36.2%), fast food and salty snacks (32.4%), alcohol (26.6%) | — | Increase in the consumption of total food and products with high energy density. |
| Drywień et al., 2020 (41) | Poland | Whole-grain products, low-fat meat and/or egg, pulses, milk and milk products, confectionary, homemade pastry, ice cream and pudding, alcohol, water | Fruit, fish and seafood, processed meat, fast food, commercial pastry, energy drinks | No overarching interpretation provided |
| Górnicka et al., 2020 (42) | Poland | Whole-grain products, low-fat meat and/or egg, pulses, milk and milk products, confectionary, homemade pastry, alcohol, water | Fruit, fish and seafood, processed meat, fast food, commercial pastry, ice cream and pudding, sugar-sweetened beverages, energy drinks | Positive and negative on dietary–lifestyle changes |
| First author, year (ref) | Country       | Increased                                                                 | Decreased                                                                 | Authors’ interpretation                                                                 |
|--------------------------|---------------|---------------------------------------------------------------------------|---------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| Kowalczuk et al., 2021 (43) | Poland        | Cereals, fruit, vegetable fats, dairy products, eggs, meat, animal fats, dietary supplements, sweets, water, alcohol | Potatoes, juice, fish, sugar, snacks, soft drinks                           | No overarching interpretation provided                                                   |
| Sidor et al., 2020 (39) | Poland        | Alcohol (14.6%)                                                           | —                                                                         | A significant percentage of individuals can experience modification of dietary habits, manifested by eating and snacking more |
| Gicalone et al., 2020 (59) | Denmark       | Commercial and homemade pastries (21.1% and 38.1%), fish (15.8%), alcohol (30.3%), carbonated beverages (21.4%) | Fruit (24.9%), vegetables (19.5%), legumes (99%), fast food (25.4%), fried food (17.7%), red meat (12.3%) | Dietary changes during the lockdown reflected pre-existing (un)healthy eating habits       |
| Kriaucioniene et al., 2020 (63) | Lithuania | Vegetables (18.8%), fruits (22.1%), fried food (20.6%), homemade pastries (37.7%) | Fast food (41.3%), fish and seafood (14.3%), carbonated and sugary drinks (1.94%), commercial pastries (26%), red meat (17.9%), alcohol (15.9%) | Both positive and negative changes in nutrition                                          |
| Poelman et al., 2020 (58) | The Netherlands | Sweets and snacks (22.1%)                                                  | —                                                                         | Persistence of dietary routines                                                        |
| Buckland et al., 2020 (49) | United Kingdom | Fruit (48%), vegetables (49%), high-energy-dense sweet and savory foods (28%) | —                                                                         | Eating behavior traits that increase susceptibility to increased intake of high-energy-dense sweet and savory foods were observed |
| Coulthard et al., 2021 (52) | United Kingdom | High-energy-dense snack foods, fruit and vegetables, alcohol               | —                                                                         | No overarching interpretation provided                                                   |
| Robinson et al., 2020 (51) | United Kingdom | —                                                                           | Alcohol (30%)                                                            | No overarching interpretation provided                                                   |
| Ingram et al., 2020 (64) | Scotland      | Alcohol (35.4%)                                                           | —                                                                         | No overarching interpretation provided                                                   |
| North American studies  |               |                                                                           |                                                                           |                                                                                         |
| Lamarche et al., 2021 (81) | Canada        | Whole grains, greens and beans, refined grains, total vegetables, total dairy, seafood and plant proteins, added sugar, total proteins | Whole fruits, sodium, fatty acids                                           | Improved overall diet quality                                                          |
| Bin Zarah et al., 2020 (77) | USA           | Sweets (43.8%), salty snacks (37.4%) water (35.4%), coffee or tea (31.1%), white rice or pasta (26.8%), alcoholic beverages (23.9% and 15.6%), breakfast cereals (22.3%), potatoes (22.2%), starchy vegetables (21.6%), red and processed meat (20.4% and 20.0%), white bread (1.90%), margarine or butter (16.5%), fruit and vegetable juices (11.7% and 5.3%), sugary beverages (10.6%) | Fruit (33.4%), eggs, chicken, or turkey (31%), nonstarchy vegetables (28.2%), dairy (21.6%), fish and shellfish (16.6%), nut butter (26.0%), nuts or seeds (25.3%), brown rice or whole-grain pasta (15.1%), whole-grain bread (14.1%), oils (10.7%) | No major variation in dietary patterns aside from increases in the consumption of sweets and salty snacks |

(Continued)
| First author, year (ref) | Country | Increased | Decreased | Authors’ interpretation |
|--------------------------|---------|-----------|-----------|-------------------------|
| Chenarides et al., 2020 (78) | USA | Fresh products, dairy, grains, frozen and canned food, bottled water | Fast food (48%), meat | Food consumption patterns for major food groups seemed to stay the same for the majority of participants |
| Cummings et al., 2021 (79) | USA | Added sugar (14%) | — | Little evidence that US adults ate more added sugars as compared with before the pandemic |
| Zhang et al., 2021 (80) | USA | Alcohol (39.5%) | — | No overarching interpretation provided |
| South American studies | | | | |
| Christofaro et al., 2021 (83) | Brazil | Vegetables (26.6%), fruits (25.9%) fried foods (18.8%), sweets (42.5%) | — | No overarching interpretation provided |
| Malta et al., 2020 (82) | Brazil | Sweets, savory snacks, frozen food, alcoholic beverages (17.6%) | Beans, greens, and vegetables | Worsening of lifestyles and increase in health risk behaviors |
| Tebar et al., 2021 (84) | Brazil | Sweetened food (42.6%) | — | No overarching interpretation provided |
| Martínez-Vázquez et al., 2021 (85) | Mexico | Water (36.2%), cereals, legumes, eggs, fats, coffee, sugar and sugar cane and its beverages | Alcoholic beverages (12.1%) | Positive changes in the quality of diet |
| Pertuz-Cruz et al., 2021 (86) | Colombia | | Fish, nuts, fast food (33.8%), alcohol (18.1%), fruit and vegetables, snacks | Overall trend toward unhealthier diets |
| Ares et al., 2021 (89) | Uruguay | Fruit (16.0%), vegetables and pulses (10.0%), rice/flour-based dishes (2.0%), vitamins and minerals (5.0%), water (3.0%), natural juices (2.0%) | Ultra-processed food (3.0%) | Changes related to both an increase and a decrease in the consumption of healthy foods were observed |
| Huancahui-Vega et al., 2020 (90) | Peru | Vegetables, fruit, legumes, dried fruits/nuts, eggs | Bakery products, meat, snacks, refreshment and fast-food | Increase in healthy eating habits |
| Reyes-Olavarri et al., 2020 (87) | Chile | Fruit and vegetables (30.9%) | — | No overarching interpretation provided |
| Asian studies | | | | |
| Wang et al., 2020 (92) | China | Fruit, vegetables, milk products, snacks | — | Mixed effects |
| Yang et al., 2021 (94) | China | Staple food (1.88%), animal products (19.1%), vegetables (25.3%), fruits (27.3%), nuts (26.3%), water (27.1%), snacks (38.2%) | Mushroom (19.1%), dairy (21.4%), legumes (25%) | No overarching interpretation provided |
| Zhu et al., 2021 (95) | China | Snacks and drinks, fruits, vegetables, egg, livestock/poultry meat, dairy intake, staple food intake, aquatic products, legumes | — | There was an increase in total food intake by 39% of respondents, especially in snacks and drinks |

(Continued)
### TABLE 2  (Continued)

| First author, year (ref)          | Country               | Increased                          | Decreased                                                                 | Authors’ interpretation                                                                 |
|-----------------------------------|-----------------------|------------------------------------|----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| Shrestha et al., 2020 (98)        | Nepal                 | Alcohol drinking (53.6%)           | Fruits and vegetables, pulses, egg or meat                                  | No overarching interpretation provided                                                   |
| Chopra et al., 2020 (96)          | India                 | Fast food, fried food, junk foods  | Fruits, savory snacks, sweets, candies                                       | COVID-19 marginally improved the eating behavior                                         |
| Singh et al., 2021 (97)           | India                 | Junk food (73.8%), regular alcohol intake (46.3%) | Fruits, savory snacks, sweets, candies                                      | Positive lifestyle changes                                                               |
| Husain et al., 2020 (67)          | Kuwait                | Fast food, fish and seafood,       | Fruits, savory snacks, sweets, candies                                      | No overarching interpretation provided                                                  |
| Aljohani, 2020 (72)               | Saudi Arabia          | Fast food, fried food, junk foods  | Coffee (44.8%)                                                             | Lockdown impacted on dietary behaviors in an unhealthy way                               |
| Mumena, 2020 (71)                 | Saudi Arabia          | Salty snacks (21.3%), sweet snacks (7.1%) | Coffee (44.8%)                                                             | No overarching interpretation provided                                                  |
| Radwan et al., 2020 (69)          | United Arab Emirates  | Fast food, frozen ready-to-eat meals | Fruits, vegetables, homemade pizza and sweets, hot beverages, dairy products and yogurt, legumes, white meat | Unhealthy lifestyle changes including diet                                               |
| Cheikh Ismail et al., 2020 (68)   | United Arab Emirates  | Fast food, fried food,              | Processed meat, canned fish, alcoholic intake                              | Despite an increase in Mediterranean diet adherence, the consumption of “unhealthy” food also increased |
| Galali, 2021 (76)                 | Iraqi Kurdistan       | Processed meat, canned fish,       | Dark-green leafy vegetables (33.72%), alcohol (46.7%)                      | Decrease in dietary diversification, disrupted diet and consumption patterns            |
| Matsungo et al., 2020 (91)        | Zimbabwe              | Other vegetables (48.5%), other fruits (64.9%), nuts and seeds (45.0%), cereals breads and tubers (41.1%), dairy products (44.9%) | Sweet snacks (41.1%), salty snacks (33.2%), white bread and pasta (26.6%), alcohol (32.8%) sugary drinks (19.8%) | Overall shift toward an unhealthy dietary pattern                                        |
| Gerritsen et al., 2020 (99)       | New Zealand           | Fruit (20.7%), vegetables (13.3%), legumes (2.5%), whole-meal bread and pasta (24.9%) | Sweet snacks (41.1%), salty snacks (33.2%), white bread and pasta (26.6%), alcohol (32.8%) sugary drinks (19.8%) | Overall shift toward an unhealthy dietary pattern                                        |
| Abouzid et al., 2021 (113)        | Middle East and North Africa (MENA) region | Vegetables, fruits, meat, poultry, carbohydrates, dairy products, eggs, snacks, sugars, water intake | Seashells, fast food, dietary supplements | 30.9% reported an improvement in their eating habits compared with 24.8% reported worsening of their eating habits |
| First author, year (ref) | Country | Main findings | Increased | Decreased | Authors’ interpretation |
|--------------------------|---------|---------------|-----------|-----------|-------------------------|
| Ammar et al., 2020 (102) | Europe, North-Africa, Western Asia and the Americas | Unhealthy food | Alcohol binge drinking | An unhealthy pattern of food consumption was exhibited |
| Cavagnari et al., 2021 (107) | Spain and 11 Latin American countries | Vegetables, fried foods, and alcoholic beverages (Argentina, Chile, Costa Rica, Spain, and Uruguay); sweetened drinks, pastry products (Guatemala and Paraguay); baked goods (Paraguay, Argentina and Chile); chocolate (Argentina, and Chile); beer (Spain, Paraguay, Chile, Argentina, and Mexico); wine and distillates (Spain, Paraguay, Chile, Argentina, and Mexico) | — | All the Latin American countries showed a change in their consumption patterns toward less healthy diets |
| Cheikh Ismail et al., 2020 (104) | Middle East and North Africa (MENA) region | Water | Fast food | Unhealthy lifestyle changes |
| Janssen et al., 2021 (110) | Denmark (DK), Germany (DE), and Slovenia (SI) | Sweet snacks, alcoholic drinks (DE, DK) canned food (DE) | Fruit, vegetables, meat (all countries) Fish and bread (DE, SI) Dairy products (DE, DK) | Diverging trends in all food categories analyzed |
| Molina-Montes et al., 2021 (111) | 16 European countries | Olive oil, fruits, vegetables, legumes | Fast food, fried food, red meat, soft beverages alcohol, fish, pastry | Improvement in dietary habits among European population as reflected by an increased adherence to the Mediterranean diet |
| Murphy et al., 2020 (103) | New Zealand (NZ), USA, Great Britain (GB), and the Island of Ireland (IOI) | Fruit (GB), vegetables (IOI, GB, NZ), saturated fats (IOI, GB, NZ) | — | No overarching interpretation provided |
| Pišot et al., 2020 (106) | Bosnia and Herzegovina, Croatia, Greece, Kosovo, Italy, Serbia, Slovakia, Slovenia, and Spain | — | Unhealthy food (35%), alcohol (36%) | No overarching interpretation provided |
| Papandreou et al., 2020 (112) | Spain, Greece | Pastries (69.4% Spain; 62.2% Greece), alcohol (81.2% Spain; 78.9% Greece) | — | No overarching interpretation provided |

1 Percentages indicate the proportion of subjects reporting increases/decreases in the consumption of a given food. COVID-19, coronavirus disease 2019; ref, reference; UPF, ultra-processed food.
2 Argentina, Chile, Colombia, Costa Rica, Ecuador, Guatemala, Mexico, Peru, Paraguay, Panama, and Uruguay.
3 Bosnia and Herzegovina, Croatia, Denmark, Germany, Greece, Ireland, Italy, Lithuania, Montenegro, North Macedonia, Poland, Portugal, Serbia, Slovenia, Spain, and Turkey.
Change in overall diet quality in adults

Fifteen studies analyzed changes in diet quality during lockdown as compared with before the lockdown by the use of validated dietary scores aimed to assess adherence to the Mediterranean diet (32, 33, 60, 65, 111) or to other eating patterns (23, 25, 70, 85, 86, 102), or to evaluate compliance with dietary recommendations (22, 44, 45, 81). Of note, only 3 (22, 44, 81) were cohort studies with a longitudinal design and were based on repeated dietary assessments, 10 were cross-sectional and relied on data collected retrospectively from convenience samples (23, 25, 32, 33, 45, 70, 102), whereas 2 articles (23, 25) reported cross-sectional analyses from the same population-based cohort (Table 4).

With regard to European studies, investigations from Spain and Cyprus revealed an increase in adherence to the Mediterranean diet, as reflected by an increase in the average PREvención con Dleta MEDiterránea (PREDIMED) Mediterranean Diet Adherence Screener (MEDAS) score, during the lockdown period as compared with before (32, 33, 65). An Italian study (25) found a slight improvement in diet quality as reflected by favorable changes toward a Mediterranean dietary pattern. Consistently, findings from the same cohorts revealed a mild decrease in consumption of ultra-processed food as compared with before the pandemic (23). On the contrary, another Italian cohort study found a worsening in overall diet quality as reflected by a reduction in the Dietary Quality Index (DQI) (22), while a study in Croatians reported a switch toward a Mediterranean diet (60). Nevertheless, changes towards a westernized dietary pattern were also observed in Colombia (86). Finally, results from an international survey also indicated reduced diet quality overall (102), whereas another in 16 European countries pointed to an increased adherence to the Mediterranean diet (111).

To summarize, 9 out of 15 reviewed articles analyzing changes in overall diet quality indicated an improvement in diet quality at a population level, especially among Mediterranean populations.

Dietary changes in children/adolescents

Of the 10 studies conducted among children/adolescents (Table 5), 1 longitudinal analysis in a sample of 106 Spanish children with an average age of 12.0 ± 2.6 y indicated an improvement in diet quality as measured by the Mediterranean Diet Quality Index for children and teenagers (KIDMED) score (36). The same was reported by a longitudinal investigation among 1289 Italian children with a mean age of 12.5 y who experienced an increase in the KIDMED (28). At variance, Segre et al. (30) highlighted a higher amount of food eaten (57.3%) and an increased unhealthy food intake among 82 children aged 6–14 y who were web-interviewed. Androutsos et al. (57) found that
| First author, year (ref) | Country | Increased | Decreased | Authors’ interpretation |
|--------------------------|---------|-----------|-----------|-------------------------|
| **European studies**     |         |           |           |                         |
| López-Moreno et al., 2020 (34) | Spain | Home cooking (73.5%), daily meals (23%), more efficient preparation of food (64.2%) | Food intake (33.3%) | Mixed effects |
| Rodríguez-Pérez et al., 2020 (32) | Spain | Cooking (45.7%), snacking (37.6%) | — | Despite an increase in Mediterranean diet adherence, the consumption of “unhealthy” food also increased |
| Sánchez et al., 2021 (31) | Spain | Eating continuously (17.9%), ready-to-eat foods (22%) | — | No overarching interpretation provided |
| Sánchez-Sánchez et al., 2020 (33) | Spain | Homemade desserts and pastries | — | An improvement in dietary behaviors was observed |
| Bonaccio et al., 2021 (23) | Italy | Home cooking (48.6%), number of daily meals (17.6%) | Pre-prepared meals (11.6%) | About 40% of our population switched to unfavorable eating as reflected by increased UPF intake |
| Canello et al., 2020 (21) | Italy | Food intake (42%), dietary supplements (2.3%) | — | No overarching interpretation provided |
| Di Renzo et al., 2020 (4) | Italy | Homemade food, eating (37.4%) | Delivery food | No overarching interpretation provided |
| Maffoni et al., 2021 (27) | Italy | Breakfast | Craving or eating between meals | Negative changes in eating behaviors were documented |
| Scacchi et al., 2021 (24) | Italy | Food consumption (43.4%), home cooking (55.1%) | — | The Italian lockdown highly affected food choice behaviors, leading to positive and sustainable habits towards food purchase and consumption |
| Scarmozzino et al., 2020 (20) | Italy | Eating more (52.9%) | Ready meals | No overarching interpretation provided |
| Ruggiero et al., 2021 (25) | Italy | Home cooking (49.3%), number of daily meals (17.8%) | Pre-prepared meals (12.0%), take-away (12.4%) | Higher intake of foods characterizing a Mediterranean dietary pattern, healthier lifestyle, and more sustainable food choices |
| Pfeifer et al., 2021 (60) | Croatia | Home cooking (53.8%), snacking (33.9%) | — | Increased diet quality among those cooking more |
| Mititelu et al., 2021 (61) | Romania | Amount of food eaten (25.6%), home cooking (77.5%) | — | Positive changes reflected by increases in homemade food, fruit, and vegetables |

(Continued)
| First author, year (ref) | Country | Increased | Decreased | Authors’ interpretation |
|-------------------------|---------|-----------|-----------|-------------------------|
| Kolokotroni et al., 2021 (65) | Cyprus | Number of daily meals, conviviality | — | Though participants reported eating more, their quality of diet did not seem to change |
| Deschasaux-Tanguy et al., 2020 (44) | France | Cooking (40.4%), snacking (21.1%) | — | The lockdown created an opportunity to improve nutritional behaviors, such as cooking homemade meals, increasing consumption of fresh products, and buying food products from local shop and/or farmers |
| Marty et al., 2020 (45) | France | Cooking (83.2%), energy intake | — | Decrease in the nutritional quality of diet, on average, which could be partly explained by changes in food choice motives |
| Constant et al., 2020 (46) | France | Snacking (2.4%) | — | Less than 4 in 10 respondents reported healthy changes over the same period, mostly in relation to better eating habits |
| Drieskens et al., 2021 (55) | Belgium | — | Food prepared out-of-home (39.7%) | No overarching interpretation provided |
| Blaszczyk-Bębenek et al., 2020 (38) | Poland | 5 meals or more (31.1%), snacking (77.9%) | Eating outside or ordering take-away food (51.6%) | Nutrition behavior does not change during lockdown, nor does it increase the proportion of healthy products in the diet |
| Dobrowolski et al., 2021 (40) | Poland | Amount of food eaten (48.4%) | Home delivery and take-away (37.8%) | Increase in the consumption of total food and products with high energy density |
| Drywień et al., 2020 (41) | Poland | Eating more (35.7%) Homemade meals | Take-away meals | No overarching interpretation provided |
| Górnicka et al., 2020 (42) | Poland | Eating more (34.3%), homemade meals | — | Positive and negative on dietary-lifestyle changes |
| Kowalczuk et al., 2021 (43) | Poland | Eating more regularly | Diet diversity | No overarching interpretation provided |
| Sidor et al., 2020 (39) | Poland | Eating more (43.5%), snacking (51.8%), cooking (62.3%) | — | A significant percentage of individuals can experience modification of dietary habits, manifested by eating and snacking more |
| Giacalone et al., 2020 (59) | Denmark | Cooking (29.9%), eating (42.8%) | Snacking (41.7%) | Dietary changes during the lockdown reflected pre-existing (un)healthy eating habits |
| First author, year (ref) | Country       | Increased                                                                 | Decreased                                                                 | Authors’ interpretation                                      |
|--------------------------|---------------|---------------------------------------------------------------------------|---------------------------------------------------------------------------|--------------------------------------------------------------|
| Kraucioniene et al., 2020 (63) | Lithuania     | Eating more (49.4%), snacking (45.1%), home cooking (62.1%)                | —                                                                         | Both positive and negative changes in nutrition               |
| Poelman et al., 2020 (58) | The Netherlands | Eating more (8.9%), meal delivery services (29.5%)                        | —                                                                         | Persistence of dietary routines                               |
| Buckland et al., 2020 (49) | United Kingdom | Food intake (48%), snacking (53%), number of meals (31%)                  | —                                                                         | Eating behavior traits that increase susceptibility to increased intake of HED sweet and savory foods were observed |
| Goulthard et al., 2021 (52) | United Kingdom | Home-prepared food                                                        | —                                                                         | No overarching interpretation provided                       |
| Herle et al., 2021 (53)    | United Kingdom | Amount of food eaten (17.3%)                                               | —                                                                         | One-third of the sample report changes in quantities eaten throughout the first UK lockdown period |
| Robinson et al., 2020 (50) | United Kingdom | Large meals/snacks, snacking, drinking                                    | Dieting/fasting, skipping meals                                           | No overarching interpretation provided                       |
| Robinson et al., 2020 (51) | United Kingdom | Binged on food (49%)                                                      | —                                                                         | No overarching interpretation provided                       |
| North American studies    |               |                                                                          |                                                                           |                                                              |
| Lamarche et al., 2021 (81) | Canada        | —                                                                         | Meals consumed outside, lunch consumed outside, snacking                  | Improved overall diet quality                                 |
| Chenarides et al., 2020 (78) | USA          | Eating more (21%), snacking (41.9%)                                       | Take-out meals (48%), prepared meals                                      | An overwhelming shift away from consumption away from home (e.g., fast food) to snack food consumption |
| South American studies    |               |                                                                          |                                                                           |                                                              |
| Martinez-Vázquez et al., 2021 (85) | Mexico | Homemade foods (28.4%)                                                   | —                                                                         | Positive changes in the quality of diet                      |
| Pertuz-Cruz et al., 2021 (86) | Colombia     | Snacking (48%), amount of food eaten (45%), perishable food (50.2%), expenditure on food (71%), home cooking (69.3%) | —                                                                         | Transition toward unhealthy diets                             |
| Reyes-Olavarria et al., 2020 (87) | Chile | Home cooking (59.6%), eating more (51.3%)                                 | —                                                                         | No overarching interpretation provided                       |
| Ares et al., 2021 (89)     | Uruguay       | Eating more homemade food (8.0%)                                         | —                                                                         | Changes related to both an increase and a decrease in the consumption of healthy foods were observed |
| Ramos-Padilla et al., 2021 (88) | Ecuador     | Intake of any food (44%), supplement (41.4%), or beverage (31.6%)         | —                                                                         | No overarching interpretation provided                       |
| Asian studies             |               |                                                                          |                                                                           |                                                              |
| Yang et al., 2021 (94)     | China         | —                                                                         | Breakfast frequency (2.36%), midnight snacking (15.8%)                   | No overarching interpretation provided                       |
| First author, year (ref) | Country | Increased                                                                 | Decreased                                                      | Authors’ interpretation                                                                 |
|--------------------------|---------|---------------------------------------------------------------------------|----------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Shrestha et al., 2020    | Nepal   | Quality of diet (67.6%)                                                   | Alcohol drinking (53.6%)                                       | No overarching interpretation provided                                                 |
| Husain et al., 2020      | Kuwait  | Late-night snack or meal, freshly made main meal, home cooking, skipping breakfast | Number of meals, main meal from a restaurant                    | Unhealthy meal patterns were detected                                                  |
| Al-Domi et al., 2021     | Jordan  | Food intake or supplements containing antioxidants (46.0%), breakfast (5.9%), lunch (9.8%), dinner (64.0%) | —                                                               | Significant negative changes in healthy nutritional behavior                          |
| Alhusseini et al., 2020  | Saudi Arabia | Home-cooked meals                                                        | Take-away or delivered food                                     | No overarching interpretation provided                                                |
| Aljohani, 2020           | Saudi Arabia | Food intake (63%), after dinner snacking (47.9%)                          | —                                                               | No overarching interpretation provided                                                |
| Radwan et al., 2020      | United Arab Emirates | Food intake (31.8%), cooked food (84.4%)                                | —                                                               | Unhealthy lifestyle changes including diet                                             |
| Cheikh Ismail et al., 2020 | United Arab Emirates | Homemade meals, daily meals, breakfast                                   | Frozen ready-to-eat meals, skipping meals, eating outside      | Unbalanced food choices                                                               |
| Galali, 2021             | Iraqi Kurdistan | Home cooking                                                              | Delivered food products                                         | An improvement in dietary behaviors was observed                                       |
| Oceanian studies         |         |                                                                           |                                                                |                                                                                        |
| Curtis et al., 2021      | Australia | Energy from alcohol (34.6%), food restriction (27.6%)                     | Energy from protein                                             | Small dietary changes were observed                                                   |
| Phillipou et al., 2020   | Australia | Bingeeating (34.6%), food restriction (27.6%)                           | —                                                               | Potential adverse health consequences because of increased binge eating and restricting behaviors |
| Gerritsen et al., 2020   | New Zealand | Cooking hot meals, baking                                                | —                                                               | Overall shift toward an unhealthy dietary pattern                                       |
| Intercontinental studies |         |                                                                           |                                                                |                                                                                        |
| Ammar et al., 2020       | Europe, North Africa, Western Asia, and the Americas                      | Snacking, number of meals                                          | Alcohol binge drinking                                                             | An unhealthy pattern of food consumption was exhibited                               |
| Cheikh Ismail et al., 2020 | Middle East and North Africa (MENA) region | Daily meals, homemade meals (97.2%), breakfast (71.2%)                | Frozen ready-to-eat meals (7.5%), eating outside, skipping meals (45.1%) | Unhealthy lifestyle changes                                                         |
| Dou et al., 2021         | China and USA | Home cooking, eating more                                                | Ready-to-eat food, delivery food                                | Better nutrition from increased time spent on meal planning and preparing at home     |
| Janssen et al., 2021     | Denmark (DK), Germany (DE), and Slovenia (SI) | Ready-made meals (DE, DK)                                             | Ready-made meals (SI)                                             | Diverging trends in all food categories analyzed                                      |
### Main findings

| First author, year (ref) | Country | Increased | Decreased | Authors’ interpretation |
|--------------------------|---------|-----------|-----------|-------------------------|
| Molina-Montes et al., 2021 (111) | 16 European countries | Frequency of cooking and snacking, homemade pastry | An increase in overall dietary quality and more engagement in home cooking | No overarching interpretation provided |
| Murphy et al., 2020 (103) | New Zealand, USA, Great Britain (GB), and the Island of Ireland (IOI) | Fresh ingredients for dinner (IOI and GB), baking | Ready-made dinner (not in the USA), take-away | No overarching interpretation provided |
| Pišot et al., 2020 (106) | Bosnia and Herzegovina, Croatia, Greece, Kosovo, Serbia, Slovakia, Slovenia, and Spain | Regular meals (44%), larger meal sizes | Snacking (41.4% Spain, 40.8% Greece) | Amount of food eaten (74.3% Spain, 63.1% Greece) |
| Papandreou et al., 2020 (112) | Spain, Greece | Snacking (34.1% Spain; 40.8% Greece) | Amount of food eaten (74.3% Spain, 63.1% Greece) | No overarching interpretation provided |

1 COVID-19, coronavirus disease 2019; HED, high-energy-dense; ref, reference; UPF, ultra-processed food.

### Discussion

This systematic review synthesized results from observational studies in adults and children/adolescents analyzing the impact of nationwide lockdowns resulting from the first wave of the COVID-19 pandemic on food intake, eating behaviors, and diet quality.

The majority of studies were conducted in Europe from March to September 2020 by retrospectively assessing dietary changes that occurred during lockdown as compared with before the lockdown, through the use of web-based surveys on convenience samples (4, 20, 21, 23–27, 29, 32–35, 38–43, 45–52, 54, 55, 57–80, 82, 83–100, 102–113), while only a few could rely on a longitudinal design, thus providing more robust findings (22, 28, 36, 44, 53, 55, 81, 101). In addition, more than half of the studies addressed dietary changes by asking participants to self-rate their food intake as increased, decreased, or remained stable during lockdown (4, 20, 21, 23–26, 29–31, 34, 35, 39–43, 46, 47, 49–56, 58, 59, 61–64, 66, 69, 72, 77, 78, 80, 82–84, 87–89, 91, 94, 95, 97, 98, 100, 106, 107, 109, 112), and mainly in the form of eating more/less/the...
same of a given food; others asked to report simultaneously for each food item their consumption before and during the lockdown (22, 32, 33, 38, 45, 48, 49, 57, 60, 65, 67, 68, 70, 71, 73, 74, 85, 86, 90, 92, 93, 96, 99, 100, 102–105, 110, 111). Despite the fact that the latter approach allows to assess frequency of intake and, in some cases, the amount of food consumed, both methodologies have important limitations, including recall bias.

**Studies analyzing changes in food and beverage intake**

The majority of studies assessed variations in the consumption of specific food and beverages, and this renders it difficult to obtain a global evaluation of the changes in diet quality that occurred during the lockdown period as compared with usual behaviors. According to these analyses, an increase in fruit and vegetables, legumes, cereals, olive oil, and dairy products was found. Studies were concordant in highlighting a sharp decrease in fish and seafood consumption, with only 6 studies pointing to an increasing intake (33, 45, 59, 65, 81, 95).

Most studies indicated an increase in the intake of unhealthy food and alcoholic beverages, while red and processed meat intake was lowered.

The intake of 5 out of 8 major food groups was in line with the definition of a healthful diet as reflected by the traditional Mediterranean diet (114) (i.e., increased intake

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### TABLE 4  Main findings of included observational studies from general adult populations evaluating changes in overall diet quality during the lockdown resulting from the first wave of the COVID-19 outbreak

| First author, year (ref) | Country | Main findings | Authors' interpretation |
|--------------------------|---------|---------------|-------------------------|
| Rodríguez-Pérez et al., 2020 (32) | Spain | MEDAS increased from 6.53 ± 2 (before lockdown) to 7.34 ± 1.93 (during lockdown) | Adherence to Mediterranean diet increased significantly during the lockdown |
| Sánchez-Sánchez et al., 2020 (33) | Spain | High adherence (MEDAS 2.9) increased from 4.7% (before lockdown) to 8% (during lockdown) | Mediterranean diet adherence slightly increases during lockdown, although consumption of "unhealthy" food also increases |
| Bonaccio et al., 2021 (23) | Italy | Average UPF score was −0.28 ± 4.07 | Slight decrease in the consumption of UPF |
| Cicero et al., 2021 (22) | Italy | DQI reduced from 42.4 ± 4.1 to 37.8 ± 4.7 | A trend towards decreasing diet quality |
| Ruggiero et al., 2021 (25) | Italy | Average MDP score was 0.5 ± 2.2 | A slight improvement in diet quality at a population level during the lockdown |
| Pfeifer et al., 2021 (60) | Croatia | MEDAS increased from 5.02 ± 1.97 (before lockdown) to 5.85 ± 2.04 (during lockdown) | Increased diet quality among those cooking more |
| Kolokotroni et al., 2021 (65) | Cyprus | MEDAS increased by 1 unit (median 6, IQR 3) during lockdown | Increased adherence to Mediterranean diet (31.9%) |
| Deschasaux-Tanguy et al., 2020 (44) | France | AHEI-2010 decreased by 3% during lockdown UPF decreased by 1% during lockdown | The lockdown led, in a substantial part of the population, to unhealthy nutritional behaviours. |
| Marty et al., 2020 (45) | France | sPNNS-GS2 decreased from 1.2 ± 2.5 (before lockdown) to 0.8 ± 2.8 (during lockdown) | The lockdown period in France was related to a decrease in nutritional quality of diet, on average |
| Lamarche et al., 2021 (81) | Canada | HEI-2015 increased by 1.1 points (95% CI: 0.6, 1.5) | Diet quality has slightly improved during the COVID-19-related early lockdown |
| Pertuz-Cruz et al., 2021 (86) | Colombia | Change toward a westernized-like dietary pattern | Transition toward unhealthy diets |
| Martinez-Vázquez et al., 2021 (85) | Mexico | Median DQI increased from −1 (before lockdown) to 2 (during lockdown) | DQI was higher during lockdown in all groups |
| Alhusseini et al., 2020 (70) | Saudi Arabia | Food-quality score decreased from 16.66 ± 2.84 (before lockdown) to 16.39 ± 2.79 (during lockdown); food quantity score increased from 14.62 ± 2.71 (before lockdown) to 15.70 ± 2.66 (during lockdown) | The quality and the quantity of the food was compromised |
| Ammar et al., 2020 (102) | Europe, North Africa, Western Asia, and the Americas | Total diet score 4.4% higher during lockdown than before | Isolation alters eating behaviors in a health-compromising direction |
| Molina-Montes et al., 2021 (111) | 16 European countries2 | MEDAS score increased from 5.23 ± 2.06 (before lockdown) to 6.15 ± 2.06 (during lockdown) | A significantly higher adherence to the Mediterranean diet during the lockdown was observed across all countries |

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1 Values in the main findings' column are means ± SDs. *Measured through the Short Diet Behaviours Questionnaire for Lockdowns (higher values indicating a decrease in diet quality). AHEI-2010, Alternate Healthy Eating Index–2010 score; COVID-19, coronavirus disease 2019; DQI, Dietary Quality Index; HEI-2015, Healthy Eating Index–2015; MEDAS, PREDIMED (PREvención con Dieta MEDiterránea) Mediterranean Diet Adherence Screener; ref, reference; sPNNS-GS2, Simplified Programme National Nutrition Santé—guidelines score 2; UPF, ultra-processed food.

2 Bosnia and Herzegovina, Croatia, Denmark, Germany, Greece, Ireland, Italy, Lithuania, Montenegro, North Macedonia, Poland, Portugal, Serbia, Slovenia, Spain, and Turkey.
TABLE 5  Main findings of included observational studies from general populations of children and adolescents evaluating changes in diet during the lockdown resulting from the first wave of the COVID-19 outbreak

| First author, year (ref) | Country | Increased | Decreased | Authors' interpretation |
|--------------------------|---------|-----------|-----------|-------------------------|
| Medrano et al., 2020 (36) | Spain   | KIDMED increased from 5.9 ± 1.8 to 6.4 ± 1.5 | —         | KIDMED score increased, although the prevalence of children with a high adherence to the Mediterranean diet was not significantly improved |
| Aguilar-Martínez et al., 2021 (37) | Spain   | Fruit, vegetables, cereals, dairy products, eggs, fresh food, number of meals (28.4%), snacking between meals (56.4%), amount of food eaten | Legumes, meat, fish, sweets and pastries (39.3%), convenience foods (49.2%), soft drinks (49.8%), convenience food, packaged food, regularity of meal hours | Changes towards less healthy eating were also related to students’ socioeconomic position |
| Segre et al., 2021 (30) | Italy   | Amount of food eaten (57.3%); junk food; snacks; sweets | —         | Important changes in dietary habits |
| Mastorci et al., 2021 (28) | Italy   | KIDMED increased from 6.1 ± 2.6 to 6.5 ± 2.5 | —         | Increased adherence to the Mediterranean diet |
| Androutsos et al., 2021 (57) | Greece  | Fruits and fresh fruit juices, vegetables, dairy products, pasta, sweets, total snacks | Fast food | Unfavorable changes in children’s and adolescents’ lifestyle behaviors during the first COVID-19 lockdown |
| Philippe et al., 2021 (48) | France  | Midafternoon snack increased (15%), fruit juice and soda, chips, salty biscuits, candy, chocolate, ice cream, pastries, cake, sweet cookies, cream dessert, milks, yogurt, cheese, quark, fresh and dried fruits, nuts | Compote, fruits in syrup | No overarching interpretation provided |
| Jia et al., 2020 (93) | China   | Wheat products, other staple foods, preserved vegetables, tea | Rice, meat, poultry, fresh vegetables, fresh fruit, soybean products, dairy products, sugar-sweetened beverages | Compensatory eating patterns deserve further investigation for a full evaluation of the effects of the lockdown on dietary patterns and quality |
| Al Hourani et al., 2021 (74) | Jordan  | Milk and milk products, cooked and raw vegetables, fruit, bread and grains, carbonated beverages | —         | Increased food consumption |
| Bahathec, 2021 (108) | Saudi Arabia, Britain, and Turkey | Fruit, chocolate, sweets, cakes, biscuits, and cupcakes, frozen food (pizza, nuggets, and pies), soft drinks, sweetened juices, juice blends and fruit juice | —         | Nutritional system of the Turkish and British children was better than that of Saudi children during the lockdown |
| Ruiz-Roso et al., 2020 (105) | Italy, Spain, Brazil, Chile, Colombia | Legumes, vegetables, fruit, fried food, sweet food | Fast food | Overall diet quality did not increase |

1Values in the main findings’ column are means ± SDs. COVID-19, coronavirus disease 2019; KIDMED, Mediterranean Diet Quality Index for children and teenagers; ref, reference.
of fruits and vegetables, legumes, cereals, olive oil; lower intake of red and processed meat), indicating a moderate but consistent improvement in dietary habits worldwide. On the other side, the consumption of foods that should be consumed at low to moderate amounts, such as dairy products (115), increased while fish consumption was found to be substantially decreased in most surveys.

Analyses of changes in alcohol consumption yielded mixed results, but a tendency toward increased intakes was observed. Analyses by geographic area suggest a healthier trend in nutritional patterns in European populations, showing increased consumption of fruit and vegetables, legumes, and cereals, as well as in Asian and South American countries. An unhealthful change in dietary patterns was otherwise observed in North America, where alcoholic beverage consumption increased concurrently with a lowering in fruit and vegetable intake reported by half of the surveys (Supplemental Figures 1–4).

Studies analyzing changes in overall diet quality

In addition to studies analyzing changes in major food group intakes, our systematic review identified a few investigations that used validated dietary indices to assess modification in adherence to a Mediterranean diet (32, 33, 60, 65, 111), eating patterns (23, 25, 70, 85, 86, 102), changes in compliance to national dietary recommendations, or relied on scores that are not widely used (22, 44, 45, 81).

Analyses in the Spanish adult population revealed an improvement in diet quality as reflected by increased adherence to the Mediterranean diet (32, 33), as did a longitudinal analysis conducted in a subsample of the larger NutriQuébec cohort study in Canada (81). A slight improvement in diet quality was also detected in an Italian sample (25) that consistently documented a decrease in the intake of ultra-processed foods (23). On the contrary, 1 longitudinal investigation in France highlighted a mild decrease in diet quality, in line with a web-based survey showing lower compliance with national dietary guidelines (44, 45) and a cohort study from northern Italy (22) showed a decreasing trend in diet quality. Similarly, a study in Saudi Arabia (70) and an international study surveying people from Europe, North Africa, Western Asia, and the Americas indicated poorer diet quality during lockdown as compared with before lockdown (102).

Based on such findings, a trend of improved diet quality, as reflected by an increased adherence to the Mediterranean diet, emerges in European populations, especially among Mediterranean countries (32, 33, 60, 65, 111), with the exception of France where 2 surveys indicated poor nutritional patterns possibly established during lockdown (44, 45). Outside Europe, favorable dietary changes were documented in Canada (81) and Mexico (85), while a switch to unhealthy diets was found in Saudi Arabia (70) and Colombia (86).

However, a definitive conclusion on the impact of lockdown on diet quality cannot be drawn due to the relatively small number of studies. Moreover, evaluations restricted to data from the only 3 longitudinal cohorts available are discordant since one highlighted an improvement in diet quality (81) while the other 2 observed a decrease in nutritional quality of diet, on average (22, 44).

The same applies to analyses conducted among children/adolescents that highlighted either improvements (28, 36), worsening (30, 37, 57, 74), or negligible changes in diet quality (105), or even were unable to provide conclusive evidence (48, 93, 108).

Studies analyzing changes in eating behaviors

The majority of high-quality studies are concordant in showing an increase in healthful food practices, such as homemade foods and reduced take-away/delivered food (4, 23, 33, 41, 44, 67–70, 76, 78, 81, 99, 103, 109), but at the same time, many indicated an increase in snacking and number of daily meals (21, 32, 34, 39, 44, 46, 49, 50, 59, 63, 68, 78), along with an increased amount of food eaten daily (23, 25, 34, 49, 68).

Although cooking more and consuming more fruit and vegetables, people experiencing lockdown were generally more likely to increase snacking and tended to eat more. This is potentially counterbalanced by consuming more vegetables and fruits and reduced fast food or take-away foods. However, the long-term effect of diet on health is the result of a complex interplay between a number of diet-related aspects that include foods, nutrients, and the way they are combined and consumed (116, 117).

More recently, other aspects of foods, such as the degree of food processing, have been shown to be risk factors themselves, beyond nutritional content (118).

Also, high consumption of ultra-processed food, such as sweet and salty snacks and carbonated soft drinks, leads to an increased risk of death independently of the overall diet quality (119), whereas a high intake of unhealthy foods possibly attenuates the benefits of the Mediterranean diet (120).

Although moderate alcohol intake during main meals has been positively considered within the framework of a traditional Mediterranean diet (121), the observed tendency toward an increase in the consumption of alcoholic beverages during the lockdown is worthy of attention from public health experts, in light of the detrimental effects of excessive alcohol consumption on health outcomes (122).

Strengths and limitations of this study

This is the first broad systematic synthesis of published studies evaluating changes in diet quality and eating behaviors that occurred during the nationwide lockdowns resulting from the COVID-19 pandemic.

Limitations include the possibility of our eligibility criteria to exclude important data sources and the heterogeneity of extracted data that precluded any meta-analysis. We also acknowledge that the studies considered here mainly relied on poorly accurate dietary assessments, were mostly cross-sectional, and mostly based on convenience samples; thus,
generalizability of the findings should be made with caution. Also, the majority relied on retrospective recall and this resulted in 2 major limitations—that is, recall bias and reliance on self-reported measurements.

It is worth noting that, although a small proportion of surveys used validated questionnaires/indices (e.g., MEDAS, AHEI-2010, etc.), the majority of studies (>60% of those analyzed) examined diet variations by asking participants to indicate whether they ate more/less/the same during lockdown as compared with before. Others, including cross-sectional studies using validated tools, relied on a simultaneous administration of dietary questionnaires aiming to assess food intakes (or eating behaviors) before and during lockdown. Both of these latter approaches represent a pragmatic solution to conducting research on a large sample in relation to an unexpected event (52, 100) but might lack specificity to the current pandemic state. Last, web-based surveys are equivalent to conventional face-to-face interviews in terms of data quality (123, 124).

**Conclusions**

Maintaining a healthy and balanced diet has become increasingly relevant during the current COVID-19 pandemic to support the immune system, which is a key determinant of COVID-19 prognosis for infected individuals (125). Results available to date are quite heterogeneous in dietary assessment and sampling. An analysis of food groups in isolation but lacking a global assessment of diet quality is in contrast with the most used approach in nutritional epidemiology, which is based on the assumption that the role of diet in health has to be examined as a composite of multiple nutrients and foods; indeed, people eat foods, not nutrients, and the combination of foods may be more synergistically powerful for health than any specific food or nutrient (117, 126).

For this reason, our original research question on whether the lockdown due to the COVID-19 pandemic has had an impact on diet quality at a population level could only be satisfied by studies considering diet as a whole rather than relying on single-food intake without providing a global assessment of diet quality. In light of this, the main findings of our systematic review indicate a modest improvement in diet quality in Mediterranean populations and a few other countries such as Canada and Mexico, while showing a decreased diet quality in other countries.

However, based on studies analyzing changes in major food groups, a slight improvement in dietary habits could be observed, since the healthful dietary choices seemed to counterbalance the unhealthful choices.

Future studies are warranted to evaluate to what extent dietary modifications that occurred during lockdown would possibly persist over time and what consequences this may produce in terms of newly established dietary patterns.

Future investigations should possibly overcome some major limitations of the majority of studies published so far, either by using quota-sampling or more accurate dietary assessment methods that possibly rely on the evaluation of overall diet quality.

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