

Adherence to the Mediterranean Diet during the COVID-19 national lockdowns: a systematic review of observational studies

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Abstract. *Background and aim of the work:* During the COVID-19 pandemic, many countries adopted restrictive measures to mitigate infection spread, which might have influenced people's lifestyle and dietary habits. We conducted a systematic review to evaluate the impact of national lockdowns on adherence to the Mediterranean Diet (MD). *Methods:* Studies were identified searching Medline, Embase, Web of Science, and the Cochrane Library. Studies published until 4th May 2021 were included. We only considered studies reporting original data from quantitative analysis and assessing changes in adherence to the MD, using validated dietary scores, or in consumption of MD food items. Data extraction, pooling, and quality appraisal of included studies were conducted following the PRISMA guidelines. *Results:* Forty-two studies were retrieved. After screening, 12 studies met inclusion criteria and were included in the review, of which 4 (33%) were longitudinal studies. Six (85.7%) of the seven studies that measured changes in MD adherence before-during lockdown reported an increase (rate of change of high-adherence to MD ranged between +3.3% and +21.9%). Evidence indicates that consumption of MD food items increased during lockdown but is heterogeneous in study design, quality, and findings. *Conclusions:* Our results suggest adherence to the MD during lockdown might have increased in some settings, while the determinants of such a trend are to be further explored. We raise awareness of the need to research further the impacts and long-term consequences of COVID-19 containment measures on dietary and lifestyle habits. (www.actabiomedica.it)

Key words: Mediterranean Diet, Covid-19, Lockdown, Stay-At-Home Order, Adherence, Pandemic, Diet, Food, Lifestyle

Introduction

The term "Mediterranean Diet" (MD) describes the traditional eating habits of people living in olive-growing areas and, more generally, in the territories around the Mediterranean Sea (1, 2). The MD is traditionally characterized by a predominant consumption of vegetables, fruit, legumes, whole grains, nuts, seeds,

and fish, with olive oil as the main source of added fats, small amount and low-frequency consumption of meat (especially if red and processed), a moderate consumption of dairy products, and a moderate intake of alcoholic beverages, mainly red wine during meals (3–5). In 2010, the MD was recognized by UNESCO as a Cultural Heritage of Humanity (6). Non-communicable diseases such as cancer, cardiovascular disease

(CVD), type 2 diabetes, and obesity are the leading cause of death worldwide and account for 70% of all deaths in Europe each year (7). It has been shown that these diseases are largely preventable by promoting healthy lifestyles, such as moderate alcohol consumption, physical activity, tobacco cessation, and healthy diets (8–10). The MD is commonly accepted as a likely dietary model for the prevention and control of chronic non-communicable diseases throughout life, and the protective effect of the MD against these diseases has been accurately reported by many studies (8, 11–13). However, globalization and cultural and social changes in recent years have profoundly influenced people's lifestyles, causing in most regions of the world a gradual decrease in adherence to the MD (14–16) and a simultaneous shift towards the western dietary pattern, particularly in the countries of the Mediterranean basin themselves, and in younger age groups (5, 17–19). During the COVID-19 pandemic, several containment measures such as the closure of schools, restaurants, cinema, gyms, shopping centers, cancellation of public events, up to the establishment of curfews, partial and complete lockdowns, were adopted to mitigate the spread of the disease (20–22). These containment measures have undoubtedly caused changes in people's lifestyle (23), influencing their levels of alcohol consumption (24), smoking (25, 26), other addictions (27, 28), physical activity (29), and, indeed, their dietary habits (30). In parallel, the COVID-19 pandemic is having a severe impact on the global economy, determining the worst recession since World War II (31), and the availability of material resources has been already identified as a strong determinant of adherence to the MD (32). As the available evidence is scarce and often conflicting, the purpose of this systematic review is to analyze and summarize recently published studies to assess the impacts and effects of lockdowns periods imposed to contain the COVID-19 outbreak on general population adherence to the MD.

Methods

The review's methods were defined in advance following the Prepared Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines (33). The

study protocol was registered with PROSPERO at <http://www.crd.york.ac.uk/Prospero/> on the 8th February 2021 (CRD42021232913).

Search methods for identification of studies and inclusion criteria

Studies were identified by searching the electronic databases PubMed/MEDLINE, Embase and Web Of Science, and Cochrane Library. The search strategy was first developed in PubMed using a combination of free text and Mesh terms referring to i) the COVID-19 pandemic, ii) containment measures and stay-at-home orders (i.e., *lockdown*), and iii) the Mediterranean Diet. The search strategy was then adapted for use in the other databases. Complete search strategies are available in Appendix B. Further studies were identified from consultation with experts in the field and reference listing of relevant articles. Studies published up to 4th May 2021, regardless of language, were included. We only considered for inclusion studies reporting original data from quantitative analysis. We excluded opinion papers (i.e., editorials, commentaries, and letters to the Editor) not providing original data. Only the studies considering the general population, regardless of age, were included (Appendix A).

Outcomes of interest

We considered the following outcomes: i) rate of change in adherence to MD, assessed through validated dietary scores, and ii) rate of change in the consumption of specific food items that are typically attributable to the MD during COVID-19 related lockdown periods.

Data collection and analysis

Identified studies were independently reviewed for eligibility by three authors (PGDV, DN, GM) in a two-step process; a first screening was performed based on title and abstract, while full texts were retrieved for the second screening. At both stages, disagreements were resolved through discussion with a senior researcher (AO). Data from selected articles were extracted and tabulated in a standardized pre-pi-

loted form independently by two researchers (PGDV, GM), supervised by a third and a fourth author (DN, AO), in order to evaluate the quality of the studies and the synthesis of the evidence. Extracted data included: study design, country of study implementation, study period, study population, study setting, sample size, data collection method and timing, outcomes, measurements used to assess MD adherence, and changes in consumption of specific food items reported as, but not limited to, prevalence, mean, median, mean difference, or percentage.

Quality assessment

The quality of the included studies was determined using the Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies from the National Heart, Lung, and Blood Institute by two authors (PGDV and GM). Disagreements were resolved by consensus.

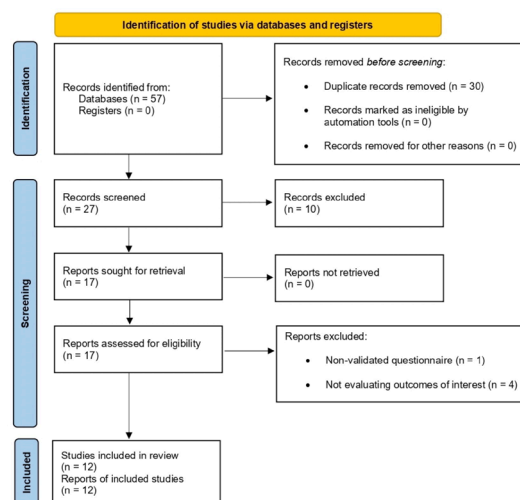
Results

Fifty-seven records were identified by searching the selected electronic databases and identified data sources. After duplicates removal, titles and abstracts of 27 records were screened. Ten studies were excluded because they were not relevant to the research question, while the other 17 were assessed for eligibility. After second screening by full-text, 12 studies were included in the systematic review. A flow diagram of the screening and selection process is reported in Figure 1.

Characteristics of included studies

The characteristics of the included studies are reported in Table 1. Most of the studies were conducted in Spain ($n=5$, 41.7%) (34–38), while 2 were conducted in Croatia (39, 40), 1 in Iraq (41), 1 in Denmark (42), 1 in Cyprus (43), 1 in Italy (44), and 1 in Kosovo (45). All included studies were in English, except one, which was published in Spanish (38). Ten (83.3%) studies (36–38, 40–45) focused on the general adult population, while one (35) (8.3%) focused on underage

(<18 years old) students, and another (39) (8.3%) on both adults and underage students. Eleven (34, 36–38, 40–45) out of twelve studies recruited convenience samples. Only one study (35) used stratified sampling. Eight studies (66.7%) had a cross-sectional design (36, 37, 39–43, 45), while 4 (33.3%) were longitudinal studies (34, 35, 38, 44). In three-quarters of the studies ($n=9$, 75%) (34, 36–38, 40–43, 45) data collection took place only during national lockdown periods and was conducted exclusively through an online survey. In the study by Dragun et al. (39), a first data collection was conducted prior to the pandemic through a paper and pencil form, while a second survey, which took place during the lockdown, was conducted using an online survey. Medrano et al. (35) used an online questionnaire to collect data both before the pandemic and during the lockdown. Finally, Ruggero et al. (44) analyzed data from a telephone interviews-based longitudinal study that began before the pandemic and ended during the lockdown, and from a cross-sectional study conducted during the lockdown. Study enrollment periods ranged from 12 days (42) to 2 years (39). In half of the studies data were collected only once during lockdown periods (36, 40–43, 45). In four studies (34, 35, 39, 44) (33.3%), data collection took place both before the COVID-19 and during the lockdown period. Sánchez-Sánchez et al. (37) collected data dur-



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For more information, visit: <http://www.prisma-statement.org/>

Figure 1. Identification of studies

Table 1. Characteristics of included studies

Reference	Country	Study population (sampling)	Study design	Data collection	First wave lockdown duration	Recruitment period	Sample size (gender)	Time of dietary data collection	Outcome	Tool	Quality assessment
Dragun (39) 2021	Croatia	Students (convenience sampling)	Cross-sectional	Survey-based: 1) Paper and pencil form 2) Online data collection	March 23 – April 27 2020	1) April – May 2018, and April – May 2019 2) May 2020	1) 1319 (M: 477, F: 842, 63.8%) 2) 531 (M: 147, F: 384, 72.3%)	Data collection occurred three times: twice before the pandemic (in 2018 and 2019) and once during lockdown (2020).	Rate of change in adherence to the Mediterranean Diet during the lockdown compared to previous periods (April – May 2018, and April – May 2019)	Mediterranean Diet Serving Score (MDSS)	8/10 Good
Franco (34) 2021	Spain	General adult population (convenience sampling)	Longitudinal	Online survey	March 15 – May 2 2020	1) October 2019 2) May 2020	297 (M: 149, 50.2%; F: 148, 49.8%)	Data collection occurred twice: once before the pandemic and once during lockdown.	Rate of change in adherence to the Mediterranean Diet during the lockdown compared to previous periods	MEDAS questionnaire	7/10 Good
Galali (41) 2021	Iraq (Kurdistan)	General population (convenience sampling)	Cross-sectional	Online survey	March 1 – May 21 2020	June 1 – June 14 2020	2137 (M: 927, F: 1210, 56.7%)	Data collection occurred once during lockdown.	Changes in the consumption of foods typically related to the MD during COVID-19 lockdown.	EBLCC- COVID19 questionnaire (Eating Behavior and Lifestyle Changes in COVID19 + other questions [MEDAS])	5/9 Fair
Giactalone (42) 2020	Denmark	General adult population (convenience sampling)	Cross-sectional	Online survey	March 15 – May 2 2020	April 24 – May 5 2020	2462 (M: 708, F: 1754, 71.3%)	Data collection occurred once during lockdown.	Changes in the consumption of foods typically related to the MD during COVID-19 lockdown.	MEDAS questionnaire + other questions	7/9 Good
Kolokotroni (43) 2021	Cyprus	General adult population (convenience sampling)	Cross-sectional	Online survey	March 15 – May 21 2020	April 10 – May 12 2020	745 (M: 195, 26.2%; F: 550, 73.8%)	Data collection occurred once during lockdown.	Rate of change in adherence to the Mediterranean Diet during the lockdown compared to previous periods (not specified)	MEDAS questionnaire	8/9 Good
Medrano (35) 2020	Spain	Students (stratified sampling)	Longitudinal	1) Online survey 2) Online survey	March 15 – May 2 2020	1) September – December 2019 2) March – April 2020	113 (M: 58, 51.3%; F: 55, 48.7%)	Data collection occurred twice: once before the pandemic and once during lockdown.	Rate of change in adherence to the Mediterranean Diet during the lockdown compared to previous periods (September – December 2019)	KIDMED questionnaire	8/10 Good

Table 1. Characteristics of included studies

Reference	Country	Study population (sampling)	Study design	Data collection	First wave lockdown duration	Recruitment period	Sample size (gender)	Time of dietary data collection	Outcome	Tool	Quality assessment
Pfeifer (40) 2021	Croatia	General adult population (convenience sampling)	Cross-sectional	Online survey	March 19 – May 11 2020	April 7 – May 4 2020	May 4281 (M: 3444, 80.5%; F: 829, 19.4%; Other: 8, 0.1%)	Data collection occurred once during lockdown.	Changes in the consumption of foods typically related to the MD during COVID-19 lockdown.	MEDAS questionnaire + other questions	6/9 Good
Rodríguez-Pérez (36) 2020	Spain	General adult population (convenience sampling)	Cross-sectional	Online survey	March 15 – May 2 2020	March 20 – April 10 2020	7541 (M: 2204, 29.2%; F: 5337, 70.8%)	Data collection occurred once during lockdown.	Rate of change in adherence to the Mediterranean Diet during the lockdown compared to previous periods (September – December 2019)	MEDAS questionnaire + other questions	7/9 Good
Ruggiero (44) 2021	Italy	General adult population (convenience sampling)	a) Longitudinal b) Cross-sectional	a) Phone interview b) Online survey	March 9 – May 3 2020	a) May – September 2020 b) June – September 2020	3161 (M: 1264, 40.0%; F: 1897, 60.0%)	a) data collection occurred three times, twice before the pandemic, and once during lockdown b) data collection occurred once during lockdown	Changes in the consumption of foods typically related to the MD during COVID-19 lockdown.	Mediterranean Dietary Pattern score [NOT VALIDATED]	6/9 Good
Sánchez-Sánchez (37) 2020	Spain	General population (convenience sampling)	Cross-sectional	Online survey	March 15 – May 2 2020	May 2020	1065 (M: 290, 27.2%; F: 775, 72.8%)	Data collection occurred once, during May 2020, coinciding with the period of confinement and the step forward into Phase 1.	Rate of change in adherence to the Mediterranean Diet during the lockdown compared to previous periods (September – December 2019)	MEDAS questionnaire	8/9 Good
Sulejmani (45) 2021	Kosovo	General adult population (convenience sampling)	Cross-sectional	Online survey	April 15 – June 9 2020	May 5 – June 9 2020	689 (M: 488, 70.8%; F: 200, 29.0%; Other: 1, 0.2%)	Data collection occurred once during lockdown.	Changes in the consumption of foods typically related to the MD during COVID-19 lockdown.	MEDAS questionnaire + other questions	7/9 Good
Tárraga Lopez (38) 2020	Spain	General adult population (convenience sampling)	Longitudinal	Online survey	March 15 – May 2 2020	Five weeks starting from March 17	490 (M: 166, 33.9%; F: 324, 66.1%)	Dietary data were collected weekly during lockdown	Rate of change in adherence to the Mediterranean Diet during the lockdown compared to previous periods (not specified)	MEDAS questionnaire + modified PRE-DIMED#	8/10 Good

ing May 2020, coinciding with the period of confinement and the step forward into “Phase 1” (the first period of loosening of restrictive measures). Finally, Tárrega Lopez et al. (38) collected data weekly during the lockdown period. Studies’ sample size ranged from 113(35) to 4281 (40) participants. The percentage of female subjects ranged from 19.4% (40) to 73.8% (43). Two-thirds (n=8, 66,7%) of the included studies (34–39, 43, 44) assessed the rate change in adherence to the MD during national lockdowns compared to previous periods. Nine studies (75%) (36–42, 44, 45) evaluated changes in the intake of foods that are typically attributable to the MD during national lockdowns compared to previous periods. Regarding the tools used to assess adherence to MD and its changes, including changes in consumption of specific foods, eleven studies resorted to validated questionnaires: nine studies (34, 36–38, 40–43, 45) used the Mediterranean Diet Adherence Score (MEDAS) (46), one study (39) used the Mediterranean Diet Serving Score (MDSS) (47), and one (35) study used the Mediterranean Diet Quality Index for Children and Adolescents (KIDMED) (48). Only one study (44) used a non-validated questionnaire (the Mediterranean Dietary Pattern score) but was nevertheless included because it assessed our secondary outcome of interest (changes in consumption of foods typically attributable to the MD).

Changes in adherence to the Mediterranean Diet during national lockdowns

Studies’ results are summarized in Table 2. Seven studies (34–39, 43) (58.3%) contained at least one measure of the rate of change in adherence to MD during lockdown assessed through the use of a validated scale. Five studies (35, 36, 38, 39, 43) (41.7%) assessed how a measure of central tendency of participants’ scores on a validated scale changed during the lockdown compared to previous periods: two of these (39, 43) considered the median, and found no change in the adherence to the MD, while the other three (35, 36, 38) considered the mean, and found an increase in the adherence to the MD. Five studies (34, 35, 37–39) (41.7%) considered possible variations in the percentage of participants who scored above or below a certain threshold on validated scales: four studies (34, 35, 37, 38) report-

ed an increase in the percentage of people complying with the MD during lockdown compared to previous periods, while one study (39) found a decrease in this percentage. Dragun et al. (39) found that, during the national lockdown, the median of the scores participants obtained on the MDSS remained unchanged (7.0 vs 7.0, $p=0.927$), and the interquartile range had decreased (6.0 vs 5.0) compared to the previous period; they also observed that the percentage of participants who could be considered compliant with the MD on the basis of the score obtained on the MDSS questionnaire had decreased by 2.9% compared to the previous period (from 12.1% to 9.2%, $p=0.077$). Franco et al. (34) found the percentage of people with high adherence to the MD based on the score obtained in the MEDAS questionnaire (46) (≥ 9 points) had increased by 21.9% during the lockdown (from 54.5% to 76.4%, $p<0.001$). Kolokotroni et al. (43) reported that, during the lockdown, the median of the MEDAS scores remained unchanged (6.0 vs 6.0). However, the interquartile range had increased (2.0 vs 3.0); furthermore, in 31.9% of the participants, the MEDAS score referring to the lockdown period was found to be higher than the score referring to the previous period, while in 22.7% of participants it was found to be lower. Medrano et al. (35) found that, in their sample, the mean score on the KIDMED (48) questionnaire had increased during the lockdown compared to the previous period from 5.9 ± 1.8 to 6.4 ± 1.5 ($p<0.02$); they also reported that the percentage of participants with a KIDMED questionnaire score of less than 8 (thus those whose MD adherence can be considered low) had decreased from 81.1% to 76.4% during lockdown ($p=0.476$). Rodríguez-Pérez et al. (36) asked the participants to fill in the MEDAS questionnaire reporting their eating habits both during the lockdown and in the previous period. First, they found that, during the lockdown, the mean score was higher (6.53 ± 2.0 to 7.34 ± 1.93 , $p<0.001$) compared to the previous period. Furthermore, considering the lockdown period, the average score of the participants who had scored at least 9 points was 9.8 (SD=0.9, $p<0.001$), while the mean of the scores that these same participants obtained by answering about their eating habits in the previous period was 8.7 (SD=1.6, $p<0.001$). For those whose lockdown period scores were above 6, but below

Table 2. Results: adherence to MD, assessed through the use of validated dietary scores

Reference	MDSS score median (IQR)	Participants compliant with the Mediterranean Diet based on MDSS score ¹ , %	Participants with high adherence to the Mediterranean Diet based on MEDAS score (MEDAS score ≥ 9), %	Participants with high adherence to the Mediterranean Diet based on MEDAS score (MEDAS score ≥ 10), %	MEDAS score median (IQR)	Change in the MEDAS score compared to the month before the lockdown, % of participants	KIDMED score (mean \pm SD)	Participants with low adherence to the Mediterranean diet (KIDMED score < 8), %	MEDAS score (mean \pm SD)
Dregun (39) 2021	<ul style="list-style-type: none"> • Before (2018-2019): 7.0 (6.0) • During: 7.0 (5.0) (Mann-Whitney U test, $p=0.927$)	<ul style="list-style-type: none"> • Before (2018-2019): 12.1 • During: 9.2 ($p=0.077$) 							
Franco (34) 2021			<ul style="list-style-type: none"> • Before (october 2019): 54.5 • During: 76.4 (Degrees of freedom – Pearson $\chi^2=22.26$; $p<0.001$)						
Kolokotroni (43) 2021					<ul style="list-style-type: none"> • Before (adherence in february 2020 - the month before lockdown): 6.0 (2.0) • During: 6.0 (3.0) (Wilcoxon signed-rank test)	<ul style="list-style-type: none"> • Increase: 31.9 • Decrease: 22.7 • No change: 45.4 ($p<0.01$) 			
Medrano (35) 2020							<ul style="list-style-type: none"> • Before (September -December 2019): 5.9\pm1.8 • During: 6.4\pm1.5 ($p=0.018$) 	<ul style="list-style-type: none"> • Before (September -December 2019): 81.1 • During: 76.4 ($p=0.476$) 	
Rodriguez-Pérez (36) 2020									<ul style="list-style-type: none"> • Before: 6.53\pm2.0 • During: 7.34\pm1.93 ($p<0.001$)
Sánchez-Sánchez (37) 2020			<ul style="list-style-type: none"> • Before: 4.7 • During: 8.0 (McNemar-Bowker test $\chi^2=274.76$; $p<0.001$)						
Tárraga Lopez (38) 2020				<ul style="list-style-type: none"> • Initial (first week of lockdown): 77.3 • Final (fifth week of lockdown): 87.9 ($p=0.859$) 					<ul style="list-style-type: none"> • Initial: 10.03\pm1.9 • Final: 10.47\pm2.1 ($p=0.016$)

Table 3. Results: changes in cereal consumption during national lockdowns compared to previous periods

References	All cereals		Whole grain cereals	Bread
	Intake during lockdown compared to previous periods	Servings per meal	Intake during lockdown compared to previous periods	Intake during lockdown compared to previous periods
Dragun (39) 2021		1–2 servings per main meal (breakfast, lunch, and dinner) Before: 35.6% During: 24.1% ($p < 0.001$)		
Galali (41) 2021	Unchanged: 99.8% Increased: 0.1% Decreased: 0.1%			Unchanged: 99.8% Increased: 0.1% Decreased: 0.1%
Ruggiero (44) 2021	Unchanged: 70.8% Increased: 25.7% Decreased: 3.5% Overall percentage change: 22.2 ($p < 0.0001$)		Unchanged: 86.5% Increased: 10.3% Decreased: 3.2% Overall percentage change: 7.1 ($p < 0.0001$)	

9 points, the average score was 7.0 (SD=0.8, $p < 0.001$), while the average score obtained when considering the answers they gave referring to the previous period was 6.2 (SD=1.2, $p < 0.001$). Finally, for those whose lockdown period scores were below 6, the average score was 4.5 (SD=0.7, $p < 0.001$), while the mean score obtained when considering the answers they gave referring to the previous period was 4.2 (SD=0.9, $p < 0.001$). Sánchez-Sánchez et al. (37) found the percentage of people with high adherence to the MD based on the score obtained in the MEDAS questionnaire (≥ 9 points) had increased by 3.3% during lockdown (from 4.7% to 8.0%, $\chi^2=274.76$, $p < 0.001$). Tárrega Lopez et al. (38) found the percentage of people with high adherence to the MD based on the score obtained in the MEDAS questionnaire (≥ 10 points) had increased from the first week of lockdown to the fifth week of lockdown by 10.6% (from 77.3% to 87.9%, $p=0.859$). Furthermore, they reported that in the first week of lockdown, the average score was 10.03 ± 1.9 , while at the end of the fifth week it had increased to 10.47 ± 2.1 ($p < 0.02$).

Changes in the consumption of foods that are typically attributable to the Mediterranean Diet during national lockdowns

Three studies (39, 41, 44) (25% of included studies) analyzed changes in cereal consumption during national lockdowns compared to earlier periods (table 3). Results are conflicting: one study (39) (33.3%) found a

decrease in cereal consumption, one study (44) (33%) found an increase (44), and another study (33%) found no significant difference (41). The consumption of legumes during national lockdowns compared to earlier periods was analyzed by eight studies (36, 37, 39–42, 44, 45), 66.7% of the total (table 4): seven (36, 37, 39–41, 44, 45) (87.5%) of them found an increase in consumption, one (42) (12.5%) found a decrease. Six studies (36, 40–42, 44, 45) reported the percentage of people who had changed their consumption of legumes during the lockdown: the percentage of those who had increased it ranged from 7.1% to 14.9%, the percentage of those who decrease it ranged from 3.9% to 11.0%, while the percentage of those who maintained it stable ranged from 75.0% to 84.4%. Eight studies (36, 37, 39–42, 44, 45), 66.7% of the total, looked at possible changes in vegetable consumption (table 5): only one (42) (12.5%) found a decrease in consumption, while the other seven (36, 37, 39–41, 44, 45) (87.5%) found an increase. The percentage of participants who changed their vegetable consumption during national lockdowns was reported in seven studies (36, 39–42, 44, 45): the percentage of participants who had increased it ranged from 11.3% to 50.0%, the percentage of those who decreased it ranged from 3.2% to 19.5%, the percentage of those who did not change their consumption ranged from 46.0% to 72.7%. Changes in fruit consumption during lockdown were investigated by eight studies (36, 37, 39–42, 44, 45), 66.7% of the total (table 6). Fruit consumption during national lockdowns was found to have increased compared to previous periods in seven studies (36, 37,

Table 4. Results: changes in legume consumption during national lockdowns compared to previous periods

References	Intake during lockdown compared to previous periods	Servings per week
Dragun (39) 2021		<i>2 or more servings per week</i> Before: 53.3% During: 60.6% ($p < 0.05$)
Galali (41) 2021	Unchanged: 76.0% Increased: 13.0% Decreased: 11.0%	
Giacalone (42) 2020	Unchanged: 84.4% Increased: 7.1% Decreased: 8.6% (cramer's V: 0.08; $p < 0.001$)	
Pfeifer (40) 2021	Unchanged: 83.0% Increased: 10.9% Decreased: 6.1% ($p = 0.025$)	
Rodríguez-Pérez (36) 2020	Unchanged: 78.1% Increased: 14.7% Decreased: 7.2%	
Ruggiero (44) 2021	Unchanged: 81.2% Increased: 14.9% Decreased: 3.9% Overall percentage change: 11.0 ($p < 0.0001$)	
Sánchez-Sánchez (37) 2020		<i>2 or fewer servings (150 g) per week</i> Before: 74.5% During: 68.4%
		<i>3 or more servings (150g) per week</i> Before: 25.4% During: 31.5% ($p < 0.001$)
Sulejmani (45) 2021	Unchanged: 75.0% Increased: 14.0% Decreased: 11.0% ($p = 0.188$)	

39–41, 44, 45) (87.5%), while in one (42) study (12.5%) it was found to have decreased. In the seven studies reporting them (36, 39–42, 44, 45), the percentage of people who declared they had increased their fruit consumption during the lockdown ranged from 11.1% to 60.1%, the percentage of people who declared they had decreased it ranged from 5.2% to 24.9%, while the percentage of people who declared they had not changed their consumption ranged from 25.5% to 72.0%. Four (37, 39, 41, 44) of the included studies (33.3%) looked for changes in nut consumption during national lockdowns (Table 7): three (37, 41, 44) of these (75%) found an increase in consumption compared to previous peri-

Table 5. Results: changes in vegetable consumption during national lockdowns compared to previous periods

References	Intake during lockdown compared to previous periods	Servings per main meal	Servings per day
Dragun (39) 2021	Unchanged: 72.1% Increased: 24.7% Decreased: 3.2% ($p < 0.001$)	<i>2 or more servings per main meal</i> Before: 21.6% During: 22.2%	
Galali (41) 2021	Unchanged: 49.4% Increased: 39.2% Decreased: 11.4%		
Giacalone (42) 2020	Unchanged: 69.2% Increased: 11.3% Decreased: 19.5% (cramer's V: 0.11; $p < 0.001$)		
Pfeifer (40) 2021	Unchanged: 69.8% Increased: 21.2% Decreased: 9.0% ($p < 0.001$)		
Rodríguez-Pérez (36) 2020	Unchanged: 72.7% Increased: 15.8% Decreased: 11.5%		
Ruggiero (44) 2021	Unchanged: 67.4% Increased: 26.2% Decreased: 6.4% Overall percentage change: 19.8 ($p < 0.0001$)		
Sánchez-Sánchez (37) 2020			<i>1 or fewer servings (garnishes and accompaniments would be 1–2 portions, 1 portion is equal to 200 g)</i> Before: 52.9% During: 47.1%
			<i>2 or more servings (none of them in salad or raw)</i> Before: 17.6% During: 20.0%
			<i>2 or more servings (some of them in salad or raw)</i> Before: 51.70% During: 51.7% ($p = 0.032$)
Sulejmani (45) 2021	Unchanged: 46.0% Increased: 50.0% Decreased: 4.0% ($p = 0.835$)		

ods, while one (39) (25%) found a decrease in consumption. The percentage of participants who changed their nut consumption during national lockdowns was reported in two studies (41, 44): the percentage of participants

Table 6. Results: changes in fruit consumption during national lockdowns compared to previous periods

References	Intake during lockdown compared to previous periods	Servings per main meal	Servings per day
Dragun (39) 2021	Unchanged: 60.1% Increased: 34.5% Decreased: 5.4% ($\chi^2=0.507$)	1–2 servings per main meal Before: 58.6% During: 65.3% ($p<0.05$)	
Galali (41) 2021	Unchanged: 25.5% Increased: 60.1% Decreased: 14.4%		
Giacalone (42) 2020	Unchanged: 64.0% Increased: 11.1% Decreased: 24.9% (cramer's V: 0.08; $p<0.001$)		
Pfeifer (40) 2021	Unchanged: 68.7% Increased: 21.7% Decreased: 9.7% ($p<0.001$)		
Rodríguez-Pérez (36) 2020	Unchanged: 69.0% Increased: 17.7% Decreased: 13.3%		
Ruggiero (44) 2021	Unchanged: 72.0% Increased: 22.8% Decreased: 5.2% Overall percentage change: 17.6 ($p<0.0001$)		
Sánchez-Sánchez (37) 2020			2 or fewer servings Before: 72.5% During: 64.3% 3 or more servings Before: 27.5% During: 35.7% ($p<0.001$)
Sulejmani (45) 2021	Unchanged: 43.0% Increased: 51.0% Decreased: 6.0% ($p=0.739$)		

who had increased it ranged from 10.7% to 30.9%, the percentage of those who decreased it ranged from 5.8% to 13.3%, the percentage of those who did not change their consumption ranged from 55.8% to 83.5%. Eight (36, 37, 39–42, 44, 45) (66.7%) of the studies included in our systematic review looked at possible changes in meat consumption (table 8). Two studies (36, 39) asked participants about their consumption of meat and processed meat in general during lockdown respect previous periods, and reported the percentage of those who had increased it, decreased it, or maintained it stable: their outcomes were conflicting since Dragun et al. (39) found the percentage of those who had increased their

Table 7. Results: changes in nut consumption during national lockdowns compared to previous periods

References	Intake during lockdown compared to previous periods	Servings per week	Servings per day
Dragun (39) 2021			1–2 servings Before: 18.9% During: 15.1% ($p<0.05$)
Galali (41) 2021	Unchanged: 55.8% Increased: 30.9% Decreased: 13.3%		
Ruggiero (44) 2021	Unchanged: 83.5% Increased: 10.7% Decreased: 5.8% Overall percentage change: 4.9 ($p<0.0001$)		
Sánchez-Sánchez (37) 2020			2 or fewer servings (1 serving= 30 g) Before: 70.80% During: 58.60% 3 or more servings (1 serving= 30 g) Before: 29.20% During: 41.40% ($p<0.001$)

consumption was higher than the percentage of those who had decreased it (12.1% vs 8.5%), while Rodríguez-Pérez et al. (36) found an opposite result (7.0 vs 21.7%). Two studies assessed changes in consumption of white meat and found different results (39, 44): Dragun et al. (39) found it had decreased, while Ruggiero et al. (44) found it had increased. Of the seven studies investigating the consumption of red meat (37, 39–42, 44, 45), five (39, 40, 42, 44, 45) (71.4%) found it had decreased, while two (37, 41) (28.6%) found it had increased. Three studies (39, 41, 44) (25% of the included studies) assessed variations in dairy products consumption during national lockdowns compared to previous periods, and all (100%) found an increase in consumption of all types of dairy products they considered (table 9). Only two studies (39, 41) (16.7% of included studies) examined egg consumption, and both (100%) found it had increased during national lockdowns compared to previous periods (table 10). Seven (36, 37, 39, 40, 42, 44, 45) (66.7%) of the included studies analyzed changes in olive oil consumption during national lockdowns compared to previous periods (table 11): two (39, 42) of them (28.6%) found that it had decreased, five (36,

Table 8. Results: changes in meat consumption during national lockdowns compared to previous periods

References	Meat and processed meat		White meat		Red meat		Reconstituted meat		Cured meat	
	Intake during lockdown compared to previous periods	Intake during lockdown compared to previous periods	Servings per week	Intake during lockdown compared to previous periods	Servings per day	Servings per week	Intake during lockdown compared to previous periods	Servings per week	Intake during lockdown compared to previous periods	Intake during lockdown compared to previous periods
Dragun (39) 2021	Unchanged: 79.5% Increased: 12.1% Decreased: 8.5% ($\chi^2=0.316$)	2 servings Before: 26.1% During: 25.6%		Unchanged: 62.9% Increased: 21.6% Decreased: 15.5%		<2 servings Before: 33.2% During: 33.9%				
Galali (41) 2021				Unchanged: 76.2% Increased: 11.5% Decreased: 12.3% (cramer's V: 0.05; p=0.071)						
Giacalone (42) 2020				Unchanged: 69.0% Increased: 9.2% Decreased: 21.95% (p<0.001)						
Pfeifer (40) 2021	Unchanged: 71.3% Increased: 7.0% Decreased: 21.7%									
Rodriguez-Pérez (36) 2020				Unchanged: 79.9% Increased: 8.4% Decreased: 11.7% Overall percentage change: 3.3 (p<0.0001)						
Ruggiero (44) 2021				Unchanged: 80.1% Increased: 15.1% Decreased: 4.8% Overall percentage change: 10.3 (p<0.0001)						
Sánchez-Sánchez (37) 2020					1 or fewer servings (1 serving= 100-150g) Before: 87.1% During: 82.7% 2 or more servings (1 serving= 100-150g) Before: 12.9% During: 17.3% p<0.001					
Sulejmani (45) 2021				Unchanged: 48.0% Increased: 15.0% Decreased: 37.0% (p<0.121)						

Table 9. Results: changes in dairy products consumption during national lockdowns compared to previous periods

References	All dairy products			Milk and yogurt			Fruit yogurt			Hard cheese			Soft cheese		
	Intake during lockdown compared to previous periods	Servings per day	Intake during lockdown compared to previous periods	Intake during lockdown compared to previous periods	Intake during lockdown compared to previous periods	Intake during lockdown compared to previous periods	Intake during lockdown compared to previous periods	Intake during lockdown compared to previous periods	Intake during lockdown compared to previous periods	Intake during lockdown compared to previous periods	Intake during lockdown compared to previous periods	Intake during lockdown compared to previous periods	Intake during lockdown compared to previous periods	Intake during lockdown compared to previous periods	
Dragun (39) 2021		2 servings Before: 31.8% During: 22.4% (p<0.001)													
Galali (41) 2021	Unchanged: 48.2% Increased: 27.9% Decreased: 23.9%		Unchanged: 69.5% Increased: 18.7% Decreased: 11.8%												
Ruggiero (44) 2021			Unchanged: 83.4% Increased: 13.4% Decreased: 3.2% Overall percentage change: 10.2 (p<0.0001)	Unchanged: 86.7% Increased: 7.9% Decreased: 5.4% Overall percentage change: 2.5 (p<0.0001)	Unchanged: 83.2% Increased: 10.7% Decreased: 6.1% Overall percentage change: 4.6 (p<0.0001)	Unchanged: 81.4% Increased: 12.5% Decreased: 6.1% Overall percentage change: 6.4 (p<0.0001)									

Table 10. Results: changes in egg consumption during national lockdowns compared to previous periods

References	Intake during lockdown compared to previous periods	Servings per week
Dragun (39) 2021		2-4 servings Before: 53.6% During: 56.1%
Galali (41) 2021	Unchanged: 60.4% Increased: 28.5% Decreased: 11.1%	

Table 11. Results: changes in olive oil consumption during national lockdowns compared to previous periods

References	Intake during lockdown compared to previous periods	Servings per main meal	Servings per day
Dragun (39) 2021		1 serving per main meal Before: 12.1% During: 11.9% (p<0.05)	
Giacalone (42) 2020	Unchanged: 88.8% Increased: 5.5% Decreased: 5.7% (cramer's V: 0.02; p=0.680)		
Pfeifer (40) 2021	Unchanged: 81.2% Increased: 12.4% Decreased: 6.4% (p<0.001)		
Rodríguez-Pérez (36) 2020	Unchanged: 72.7% Increased: 15.8% Decreased: 11.5%		
Ruggiero (44) 2021	Unchanged: 86.1% Increased: 12.6% Decreased: 1.3% Overall percentage change: 11.3 (p<0.0001)		
Sánchez-Sánchez (37) 2020		3 or fewer servings (1 serving= 1 tablespoon) Before: 52.9% During: 47.1%	4 or more servings (1 serving= 1 tablespoon) Before: 47.1% During: 52.9% (p<0.001)
Sulejmani (45) 2021	Unchanged: 67.0% Increased: 23.0% Decreased: 10.0% (p=0.402)		

37, 40, 44, 45) found that it had increased (71.4%). In the five studies (36, 40, 42, 44, 45) that assessed them, the percentage of participants who had increased their consumption ranged between 5.5% and 23.0%, the percentage of participants who had decreased their consumption ranged between 1.3% and 11.5%, while participants who had not changed their consumption ranged between 67.0% and 88.8%. Eight studies (37, 39–42, 44, 45) (66.7% of the included studies) assessed changes in fish consumption during national lockdowns compared to previous periods (table 12): four (40, 41, 44, 45) (50%) of them reported a decrease in fish consumption, the other four (36, 37, 39, 42) (50%) reported a decrease in fish consumption. Four studies (36, 40, 42, 45) reported the percentage of people who had changed their consumption of fish in general (both fresh and frozen seafood, and fresh, canned, frozen or dried fish) during national lockdowns: the percentage of those who had increased it ranged from 7.2% to 15.8%, the percentage of those who decrease it ranged from 8.4% to 20.4%, while the percentage of those who maintained it stable ranged from 72.0% to 75.8%. Finally, six studies (36, 37, 40–42, 45) (50% of included studies) assessed changes in consumption of alcoholic beverages in general, or specific alcoholic beverages (wine and beer) during national lockdowns compared to previous periods (table 13). Four studies (36, 40, 42, 45) reported the percentage of people who had changed their consumption of alcoholic beverages in general: two (36, 42) (50%) found it had increased, while the other two (40, 45) (50%) found it had decreased; specifically, in these studies the percentage of those who had increased it ranged from 4.0% to 57.3%, the percentage of those who decrease it ranged from 10.4% to 43.0%, while the percentage of those who maintained it stable ranged from 32.3% to 62.2%.

Quality assessment

The quality assessment of included studies is reported in Table 1. Quality was rated as “good” in 11 studies (28–34,36–39) (91.7%), “fair” in one (41). We determined that most of the studies were susceptible to recall bias because participants were asked to remember what their diet was like before the lockdown. Since many studies were based on non-representative samples, the authors resorted to post-stratification.

Conclusions

The MD represents a valuable dietary model for the prevention and control of obesity (49–52), metabolic syndrome (11, 53) and related chronic non-communicable diseases (8, 12); however, in recent years, in most regions of the world, globalization and cultural and social changes have caused a progressive abandonment of it and a simultaneous shift towards the western dietary pattern (14–16), which, on the contrary, has been associated with weight gain (54–56) and cardio-metabolic traits (57–59). It is a matter of concern that this phenomenon is particularly pronounced in the countries of the Mediterranean basin themselves and in the younger age groups (5, 17, 18). During the COVID-19 pandemic, several non-pharmacological interventions were adopted all around the world to mitigate the spread of the disease (20, 21). These containment measures, especially national lockdowns, have undoubtedly caused changes in people’s lifestyle (24, 25, 29), also influencing their dietary habits (30, 60–63), although it is not yet clear whether and how they influenced adherence to the MD, as available evidence is scarce and conflicting. The possibility that adherence to the MD had decreased during national lockdowns would be worrisome since it could be a clue supporting the hypothesis that the COVID19 pandemic may have exacerbated other pre-existing “pandemics”, such as obesity and metabolic syndrome (64–70) especially if this phenomenon were to continue even if these restraining measures were no longer necessary. The purpose of this systematic review was to analyze and summarize recently published studies to assess the impacts and effects of lockdowns periods on general population adherence to the MD and its determinants.

Overall, six (34–38, 43) out of the seven studies reporting a rate of change in adherence to the MD, assessed through the use of validated dietary scores, found an increase in the proportion of participants with high MD adherence during the national blocking periods compared to previous periods, while one (39) found a decrease. The results of our systematic review are consistent with other research suggesting that, during national lockdowns, people increased their intake of some healthy foods (e.g. fruit and vegetables and

Table 12. Results: changes in fish consumption during national lockdowns compared to previous periods

References	Fish		Fresh fish	Canned fish	Frozen fish	Dried fish	Fresh and frozen fish
	Intake during lockdown compared to previous periods	Servings per week					
Dragun (39) 2021		2 or more servings Before: 24.4% During: 32.8% ($p<0.001$)					
Galali (41) 2021			Unchanged: 67.0% Increased: 12.0% Decreased: 21.0%	Unchanged: 74.1% Increased: 3.6% Decreased: 22.3%	Unchanged: 77.1% Increased: 2.0% Decreased: 20.9%		
Giacalone (42) 2020		Unchanged: 75.8% Increased: 15.8% Decreased: 8.4% (cramer's V: 0.07; $p=0.003$)					
Pfeifer (40) 2021		Unchanged: 72.3% Increased: 12.5% Decreased: 15.2% ($p=0.035$)					
Rodriguez-Pérez (36) 2020		Unchanged: 72.4% Increased: 7.2% Decreased: 20.4% ($p<0.001$)					
Ruggiero (44) 2021				Unchanged: 83.5% Increased: 7.1% Decreased: 9.4% Overall percentage change: 2.3 ($p<0.0016$)		Unchanged: 83.2% Increased: 3.8% Decreased: 13% Overall percentage change: 9.2 ($p<0.0001$)	Unchanged: 63.3% Increased: 13.5% Decreased: 23.2% Overall percentage change: 9.7 ($p<0.0001$)
Sánchez-Sánchez (37) 2020		2 or fewer servings (1 serving=100–150g of fish or 4–5 pieces or 200g of seafood) Before: 76.1% During: 71.5%					
Sulejmani (45) 2021		3 or more servings (1 serving=100–150g of fish or 4–5 pieces or 200g of seafood) Before: 23.9% During: 28.4% ($p<0.001$)					
		Unchanged: 72.0% Increased: 10.0% Decreased: 18.0% ($p=0.102$)					

Table 13. Results: changes in alcohol beverages consumption during national lockdowns compared to previous periods

References	Alcohol beverages	Wine	Wine and beer
	Intake during lockdown compared to previous periods	Servings per week	Intake during lockdown compared to previous periods
Galali (41) 2021			Unchanged: 82.5% Increased: 1.8% Decreased: 15.7%
Giacalone (42) 2020	Unchanged: 55.6% Increased: 30.3% Decreased: 14.1% (cramer's V: 0.05; p=0.037)		
Pfeifer (40) 2021	Unchanged: 62.2% Increased: 10.1% Decreased: 27.7% (p<0.001)		
Rodríguez-Pérez (36) 2020	Unchanged: 32.3% Increased: 57.3% Decreased: 10.4%		
Sánchez-Sánchez (37) 2020		<i>Less than 7 servings</i> Before: 96.9% During: 91.9% <i>7 or more servings</i> Before: 3.1% During: 8.1% (p<0.001)	
Sulejmani (45) 2021	Unchanged: 52.0% Increased: 4.0% Decreased: 43.0% (p=0.003)		

pulses), but may also have increased their intake of foods that should be consumed in moderation (71–74). In fact, three (36, 37, 42) out of six studies (36, 37, 40–42, 45) found an increase in alcoholic beverages consumption, and two (37, 41) out of seven authors (37, 39–42, 44, 45) found an increase in red meat consumption. Among the studies considering the change of a central tendency measure of the scores obtained by the participants on a validated scale (35, 36, 38, 39, 43), three (36, 38, 43) used the MEDAS, and one (35) used its version for children and youths, the KIDMED score; the fact that one (43) of these studies found that the median of the scores remained unchanged with an increased interquartile range (IQR), while the other three (35, 36, 38) found that the mean had increased,

could suggest that those who had increased their score during lockdown were mainly those who already had high adherence. All the studies that assessed the rate of change in adherence to the MD using a validated scale were conducted in Mediterranean countries, i.e. those where the MD is most popular, but also those where there has been the most significant reduction in adherence to this dietary pattern since the second half of the 21st century (19). All the authors found that the percentage of participants who had high compliance with the MD had increased during national lockdowns (34, 35, 37, 38), with the exception of one conducted in Croatia, which reported a decrease (39). It should be noted that the latter was the only ones to use the MDSS (47) instead of the MEDAS (46) (or its version for young people and children, the KIDMED score (48)) to determine adherence to the MD, even if, these instruments have shown considerable overlap (75). Moreover, in the study by Kolokotroni et al. (43) the percentage of participants who increased their adherence to MD during the national lockdown was higher than the percentage of participants who decreased it (31.9% vs 22.9%). This is interesting as it shows an inversion of the negative trend observed so far in the literature (5, 19). This observation suggests that most people living in Mediterranean countries may have increased their adherence to MD during national lockdowns. As emerges from our data, lockdowns might have differentially impacted adherence to MD based on the study populations. For example, in the Dragun et al. study (39), the sample included both underage and adult students and, during the lockdown, adherence to MD seemed to have decreased, especially in adult international students, who constituted 10.9% of the subsample that participated in the survey that was conducted before the pandemic and 11.1% of the subsample that participated in the survey that was conducted during the national lockdown. The authors attempted to explain their findings by stating that, in comparison to domestic students, international students had even worse experiences during the COVID-19 lockdown, as they were separated from their families, friends, and familiar surroundings due to the travel ban and border restrictions, and that this situation may have strained their coping mechanisms and living habits. The proportion of participants with high

adherence to the MD varies widely between studies, even between those conducted in the same country: this is because different scales and thresholds were used, but probably also to the presence of selection biases. Data from a cross-sectional study representative of the Spanish general adult population conducted in 2008-2010 on 11,742 subjects reported 12% (95% CI: 11.3-12.7%) MD strict compliance, and 46% (95% CI: 44.7-47.7) moderate compliance (76), and these results are very different from those obtained by Franco (34), Tárrega Lopez (38), and colleagues, included in our review.

Regarding cereal consumption, the results of the included studies are heterogeneous and conflicting, and no generalizable conclusions can be drawn. Dragun (39), Galali (41), Pfeifer (40), Rodríguez-Pérez (36), Ruggiero (44), Sánchez-Sánchez (37), Sulejmani (45) and their colleagues found an increase in the consumption of legumes, vegetables and fruit, while Giacalone et al. (42) found a decrease in the consumption of these food items. For each study reporting the percentage of participants who stated that they had increased or decreased their consumption of a certain food during the lockdown, we determined the overall percentage change, i.e. the difference between the percentage of participants who reported increasing their intake and the percentage of participants who reported decreasing their intake, and found that for legumes it ranged from -1.5% to +11.0%, for vegetables from -8.2% to +50.0%, and for fruit from -13.9% to +45.7%. Three (37, 41, 44) of the four studies that assessed nut consumption concluded that it had increased during the lockdown (the overall percentage change ranged from +4.9% to 17.6%), while one (39) found that it had dropped. Cooking time may have grown during confinement, resulting in higher consumption of healthy foods (34, 35). The data is very heterogeneous and difficult to compare when it comes to meat consumption, so it is impossible to summarize the effect of lockdowns on consumption, which appears to vary greatly by geographical area. However, four studies (40, 42, 44, 45) reported a reduction in red meat intake, while three (37, 39, 41) studies found an increase. Two studies (41, 44) found that dairy consumption had increased during lockdowns compared to earlier periods, while one found that it had decreased (39).

Data on egg consumption is limited because just two studies (39, 41) have analyzed it, but it appears to have increased in general. Five studies found an increase in olive oil use (36, 37, 40, 44, 45), while one study found a modest decline (42) (the overall percentage change ranged from -0.2% to +13.0%). Data on fish consumption is also heterogeneous; nevertheless, six studies (37, 39, 41, 42, 44, 45) found that consumption increased during national lockdowns compared to previous periods, while two studies (36, 40) found that consumption decreased. Finally, three (36, 40, 42) out of four studies found an increase in all alcoholic beverage consumption, while one (45) found a decrease (the overall percentage change ranged from -39.0% to 46.9). An increase in alcohol consumption has indeed been reported by some authors and may have constituted a coping strategy in some populations (77). Our results suggest a possible increase in adherence to DM in some settings and in the consumption of healthy foods during COVID-19-related national lockdown, but also a possible increase in consumption of unhealthy foods. The study "COVID-19 impact on consumer food behaviours in Europe", which was funded by the European Institute of Innovation & Technology (EIT) and involved 5000 consumers in 10 European countries, found that from the beginning of the COVID-19 outbreak to September 2020, the majority of people spent more time cooking and experimenting with new recipes (78). Home cooking makes people have an active role in their dietary habits and could influence a healthy diet follow-up (79). However, the stress and boredom associated with isolation may have increased emotional eating (36), leading to a concomitant increase in comfort food consumption and unhealthy food in general; for example, an increase in the amount and frequency of snack consumption has been reported by eight (36, 37, 40, 41, 43-45) of the included studies. Another finding of our review is that the COVID-19 pandemic may have most adversely affected the most vulnerable groups in society (35, 36, 44, 80) who should be particularly supported in accessing safe and healthy food and understanding the importance of healthy dietary choices. Our study has both strengths and limitations. To the best of our knowledge, it is the first systematic review conducted to assess changes in adherence to the Mediterranean diet during COVID-19 related

national-level stay-at-home orders; we included only studies using validated scales to assess MD adherence and we applied solid systematic reviews' methodology. Nevertheless, some limitations should also be considered. Firstly, all observational studies could be prone to recall bias or social desirability bias affecting the certainty and quality of data collected. This is particularly true for cross-sectional studies that are also potentially affected by reverse causality. Moreover, included studies may be subject to selection bias, potentially affecting representativeness since all of the included studies used snowball sampling, except the study by Medrano et al. (35), used snowball sampling. Finally, the studies' results were heterogeneous for several reasons: for example, different MD scores were used, with different score thresholds to define adherence to MD, and different study populations were considered. The results of our systematic review provide useful insights into the implications of restrictive measures, particularly national lockdowns, on dietary habits and contribute to public health policy decision-making. Further research will be useful to better identify the determinants of adherence to MD and which strategies can be adopted to sensitize people to adopt healthy lifestyles.

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APPENDIX A: CRITERIA FOR INCLUSION AND EXCLUSION OF STUDIES

	Inclusion	Exclusion
Population	General population regardless of age	Pregnant women, community-dwelling seniors
Exposure	COVID-19 Lockdown	
Comparison	-	-
Outcome	Rate of change in adherence to the Mediterranean Diet assessed through the use of validated scales, Changes in consumption of food items typically related to the Mediterranean Diet	Rate of change in adherence to the Mediterranean Diet assessed through the use of non-validated scales
Study design	Original studies	Opinion papers

APPENDIX B: SEARCH STRATEGY AND IDENTIFICATION OF STUDIES

Research Question: What was the impact of national lockdowns due to the CoViD-19 pandemic on adherence to the Mediterranean diet?

Search components:

1. COVID-19
2. lockdown
3. mediterranean diet

Search strategy:

SET	Key word and actions	Search Component
1	coronavirus [tiab]	1. COVID-19
2	“novel coronavirus” [tiab]	
3	nCoV [tiab]	
4	covid-19 [tiab]	
5	covid [tiab]	
6	SARS-CoV-2 [tiab]	
7	COVID-19 [Mesh]	
8	Sets 1-7 were combined with “OR”	
9	“stay-at-home order*”[tiab]	2. lockdown
10	lockdown*[tiab]	
11	confinement[tiab]	
12	shutdown*[tiab]	
13	quarantine* [tiab]	
14	Sets 9-13 were combined with “OR”	
15	“mediterranean diet*”	3. mediterranean diet
16	“Diet, Mediterranean”[Mesh]	
17	Sets 15-16 were combined with “OR”	
18	Sets 8 and 14 and 17 were combined with “AND”	1 and 2 and 3 combined

Search string for PubMed:

((coronavirus [tiab] OR “novel coronavirus” [tiab] OR nCoV [tiab] OR covid-19 [tiab] OR covid [tiab] OR SARS-CoV-2 [tiab] OR COVID-19 [Mesh]) AND (“stay-at-home order*” [tiab] OR lockdown* [tiab] OR confinement [tiab] OR shutdown* [tiab] OR quarantine* [tiab]) AND (“mediterranean diet*” OR “Diet, Mediterranean”[Mesh]))

Records found on PubMed: Records identified through PUBMED searching: n = 20

Search string for Embase:

((coronavirus:ti,ab OR “novel coronavirus”:ti,ab OR nCoV:ti,ab OR covid-19:ti,ab OR covid:ti,ab OR SARS-CoV-2:ti,ab OR ‘COVID-19 /exp) AND (“stay-at-home order*”:ti,ab OR lockdown*:ti,ab OR confinement:ti,ab OR shutdown*:ti,ab OR quarantine*:ti,ab) AND (“mediterranean diet*” OR ‘Diet, Mediterranean/exp))

Records found on Embase: Records identified through Embase searching: n = 21

Search string for Web of Science:

((coronavirus OR "novel coronavirus" OR nCoV OR covid-19 OR covid OR SARS-CoV-2 OR COVID-19) AND ("stay-at-home order*" OR lockdown* OR confinement OR shutdown* OR quarantine*) AND ("mediterranean diet*" OR "Diet, Mediterranean"))

Records found on Web of Science:

Records identified through Embase searching: n = 16

Search strategy Cochrane library:

((coronavirus:ti,ab OR "novel coronavirus":ti,ab OR nCoV:ti,ab OR covid-19:ti,ab OR covid:ti,ab OR SARS-CoV-2:ti,ab OR [mh COVID-19]) AND (("stay-at-home" NEAR/2 order*):ti,ab OR lockdown*:ti,ab OR confinement:ti,ab OR shutdown*:ti,ab OR quarantine*:ti,ab) AND (("mediterranean" NEAR/2 diet*) OR [mh "Diet, Mediterranean"])

Records found:

Records identified through Cochrane library searching: n = 0

Records identified on May 4, 2021:

Records identified from:

PubMed (n = 20)

Embase (n = 21)

Web Of Science (n = 16)

Cochrane library (n = 0)

Total identified records (n = 57)

Records removed before screening:

Duplicate records removed (n = 30)[†]

Records marked as ineligible by automation tools (n = 0)

Records removed for other reasons (n = 0)

[†]Records removed by automation tools (n = 23+1)

Records removed by authors (n = 6)

Total identified studies after duplicate removal (n = 27)

Screening:

Records screened (n = 27)

Reports sought for retrieval (n = 17)

Reports assessed for eligibility (n = 17)

Studies included in review (n = 12)