

The impact of the COVID-19 pandemic on Mediterranean diet adherence: A narrative systematic review

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Abstract

Background: The COVID-19 pandemic upended many aspects of daily life. For some individuals, this was an opportunity to re-evaluate their life and make better choices, while others were overwhelmed with stressors, leading to a deterioration in mental and physical health. **Aim:** The aim of this narrative systematic review is to explore the effects of the COVID-19 pandemic on Mediterranean diet adherence. **Methods:** A systematic literature search was carried out on PubMed, Scopus and Web of Science electronic databases utilising the search terms ‘Mediterranean diet’ AND ‘COVID-19’. This yielded 73 articles that fulfilled the inclusion criteria. **Results:** The data suggests that a substantial proportion of individuals adhered less to the Mediterranean diet during the COVID-19 lockdown period. However, individuals receiving some form of lifestyle intervention had better adherence to the Mediterranean diet than their unassisted counterparts. **Conclusion:** This emphasises the importance of professional support during times of crisis to avoid deterioration of a population’s health.

Keywords

COVID-19, lockdown, Mediterranean diet, nutrition, lifestyle

Introduction

In December 2019, a novel beta-coronavirus SARS-CoV-2 was discovered to be causing cases of severe acute respiratory syndrome in Wuhan, China (Zhu et al., 2020). During February 2020, the virus spread throughout the European continent, with Italy and Spain being mostly affected, and was declared a global pandemic in March 2020 by the World Health Organization (Adhanom Ghebreyesus, 2020; Alfonso Viguria and Casamitjana, 2021; Saglietto et al., 2020). This led governments and public health authorities to institute several restrictive measures to contain the viral spread and prevent the healthcare systems from being overwhelmed. However, this resulted in suspension of medical consultations at hospitals and clinics (Bonalumi et al., 2020). Additionally, the periods of confinement (‘lockdowns’) disrupted individuals’ personal and professional life, with many reports of declining mental and physical health (Hossain et al., 2020).

It is yet unsure whether the overall impact of the pandemic on dietary habits was a positive or negative one, as studies reported opposing findings (Di Santo et al., 2020; Zaragoza-Martí et al., 2021). Therefore, the effect of the pandemic on adherence to the Mediterranean diet (MD) is

worth investigating. This is because the MD is recommended by several scientific organisations, including the American Heart Association (2020), as one of the best diets to follow. Associated health benefits include decreased risk of cardiovascular disease, improved insulin sensitivity and lipid profiles, as well as decreased inflammation and body mass index (BMI) (Martínez-González et al., 2015). Furthermore, the MD impacts the environment less than other diets as it encourages high plant consumption with low amounts of animal products, leading to smaller carbon and water footprints (Dermeni and Berry, 2015). The MD is defined as the traditional nutritional regime of habitants in areas abundant with olive groves and more commonly, in areas close to the Mediterranean Sea

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(Kafatos et al., 2000). However, Western dietary practices have been replacing the MD in recent years. The traditional MD is compromised of the following food groups: seasonal fruits and vegetables, legumes, whole grains, fish, dairy, eggs and olive oil (main source of lipids). These food groups are typically arranged in a diet pyramid to show the appropriate servings of each group (Salas-Salvadó et al., 2016).

A recent systemic review, with data from 1980 to 2015, concluded that the countries having the highest adherence to the MD diet were (from highest to lowest): Spain, Greece, Italy, France, Canada, other EU countries, Japan and USA (Zaragoza-Martí et al., 2018). In general, Mediterranean countries have been drifting away from the MD in recent years (Bagues et al., 2021). Globalisation created a progressive cessation of the diet with a concurrent shift to the Western diet, which promotes weight gain, cancer and cardio-metabolic traits (Obeid et al., 2022). With more time at home during the COVID-19 lockdown periods, one would anticipate that individuals had more time to improve their health (Orr et al., 2022). However, impaired mental health and boredom may decrease the motivation for healthy lifestyle choices (Hossain et al., 2020). This narrative systematic review explores the effect of lockdown periods on adherence to the MD.

Methodology

This is a narrative systematic review with the aim of synthesising literature pertaining to the reported effects of lockdowns on the adherence to Mediterranean diet.

Study selection and inclusion criteria

Article selection was carried out according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The article selection process is summarised using a PRISMA flow diagram (Figure 1). Selected articles were written in the English language between June 2020 and November 2022. The search was conducted independently by three authors (D.B, D.R., F.F.) using the electronic databases PubMed/MEDLINE, Scopus and Web of Science, using the Medical Subject Heading (MeSH) terms ‘Mediterranean diet’ AND ‘COVID-19’. The Boolean Operator ‘AND’ was included to combine search terms. Epidemiological studies that focused on changes in adherence to the Mediterranean diet during periods of lockdown in the context of the COVID-19 pandemic were included. Furthermore, hand-searching was conducted to ensure that any articles missed by the electronic search were included in this review. The inclusion criteria for this review utilised the PICOS question structure (Eriksen and Frandsen, 2018) in this manner: In the general population (population), how did COVID-19 restrictions (intervention) compared to before their implementation (comparator) affect their diet

and adherence to the Mediterranean diet (outcome) (Table 1)?

Exclusion criteria

Articles that were excluded from this review included: (1) articles that were not published in the English language; (2) articles that were not epidemiological studies (e.g., reviews, letters, opinion pieces, etc.); (3) articles that did not mention adherence to the Mediterranean diet or its main food groups during the COVID-19 pandemic; (4) articles exploring the effect of the Mediterranean diet on COVID-19 infection and death rates.

Data extraction

The following data was extracted from the articles included in this review: (1) Author; (2) Year of publication; (3) Ethnicity; (4) Total number of participants and percentage of females; (5) Mean age of participants; (6) Tool used to assess adherence to the Mediterranean diet; (7) Main findings. A quality risk assessment of all studies included in this review can be found in supplementary materials.

Results

Overview

This narrative systematic review yielded data from 73 epidemiological studies across 18 different countries to help answer the research question: ‘*Did MD adherence change during the COVID-19 pandemic?*’ Dietary habits depend largely on an individual’s culture, socioeconomic status and various psychological factors (Nicolaidis, 2019). Therefore, it is not surprising that life-changing events, such as public health emergencies, have a significant impact on one’s lifestyle, including dietary habits (Brown et al., 2012). The data analysed reveals a mixture of positive and negative dietary changes, as well as some unchanged dietary habits during the COVID-19 lockdown periods. The majority of studies described deviation away from the MD during lockdown. This was often accompanied by other negative habits, such as decreased physical activity and increased screen time. The articles included in this review and their corresponding main findings are summarised in Table 2.

Variance in Mediterranean diet adherence by age

Most studies showed that the adult age group (aged >18 years) had the highest adherence to the MD when compared to the other age groups during the COVID-19 lockdown period (Biviá-Roig et al., 2021; Di Renzo et al., 2020; Franco et al., 2021; Galali, 2021; Izzo et al., 2021; Pfeifer et al., 2021; Prete et al., 2021; Sánchez-Sánchez et al., 2020). Before the COVID-19 restrictions took place, more than half of adult participants in a study conducted

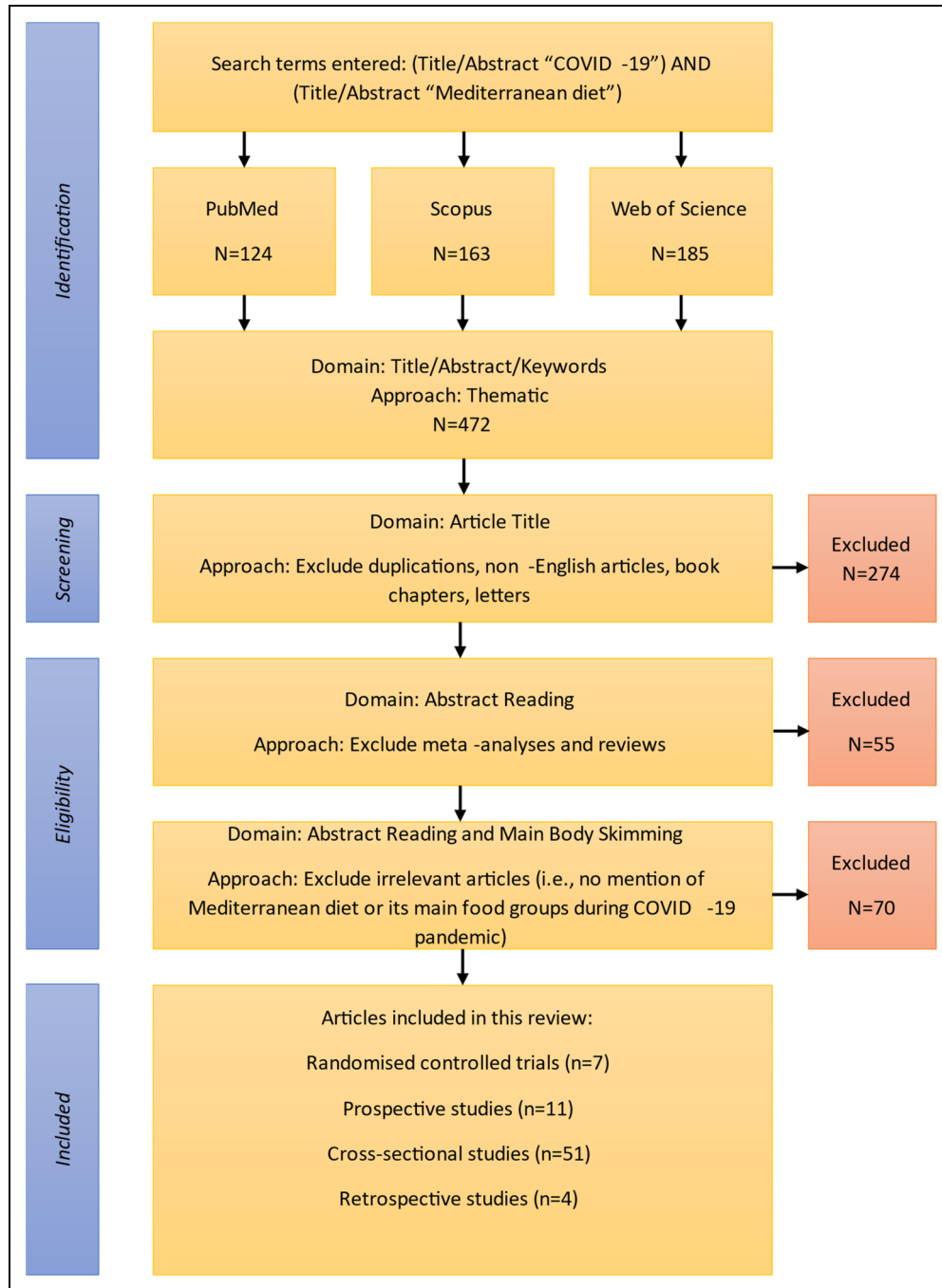


Figure 1. PRISMA flow diagram summarising the process of article selection.

Table 1. PICOS table.

Criteria	
Population	General population
Intervention	COVID-19 restrictions
Comparators	Before and after implementation of restrictions
Outcomes	Alterations in diet and adherence to Mediterranean diet
Study designs	Observational studies

by Grant et al. (2021) reported low adherence to the MD. The start of lockdown periods led some individuals to adopt more features of the MD as part of a holistic lifestyle change. This meant an increase in consumption of water, legumes, vegetables, whole grains, fruits, and the use of olive oil (Grant et al., 2021). The ‘self-improvement’ trend during lockdowns was also seen among adults in several of the other studies reviewed (Ben Hassen et al., 2021; Bonaccio et al., 2022b; Dragun et al., 2020; Lotti et al., 2022).

Table 2. Summary of reviewed literature.

Author, Year	Ethnicity	Total participants (% female)	Mean age (years)	Tool used to assess MD adherence	Main findings
Cross-sectional studies					
Álvarez-Gómez (2021)	Spain	510 (75)	N/A	Untitled questionnaire KIDMED	Most participants maintained a healthy lifestyle during the lockdown, including increased levels of physical activity and adherence to the MD.
Bagues et al. (2021)	Spain	804 (73.13)	N/A		MD adherence improved with increasing age, however, the BMI worsened by increased age. Lower BMIs were seen amongst females; younger age groups and those in possession with higher degrees of studies. The latter was also related to higher MD adherence.
Ben Hassen et al., 2022	North Africa	995 (51)	N/A	Untitled questionnaire	This study showed how the Covid-19 pandemic had a more negative effect on women than on men. When compared to men, women ate more unhealthy foods, stocked more amounts of food, changed their shopping habits more frequently and were prone to consume greater amounts of food when stressed, scared and bored.
Biviá-Roig et al. (2020)	Spain	90 (100)	33.1 ± 4.6	MEDAS	Results showed that 35.6% of participants (pregnant females) had high MD adherence. 57.8% had a moderate adherence, while the rest had low adherence.
Biviá-Roig et al. (2021)	Spain	85 (100)	33.5 ± 3.7	MEDAS	Adherence to the MD increased from the pre-confinement through to the post-confinement period. However, the overall health of participants suffered during confinement due to increased anxiety levels, increased smoking habits and reduced physical activity.
Boaz et al. (2021)	Israel	3271 (71)	30	I-MEDAS	Females consumed a higher volume of daily servings of vegetables, olive oil and weekly rations of baked sweets. Males displayed more consumption of carbonated drinks, alcohol. Legumes, red meat and tahini. Anxiety was associated with change in body weight, especially in females.
Bonaccio et al. (2022a)	Italy	2741 (59)	58.1 ± 15.3	Untitled questionnaire	Results showed that adherence to the MD decreased with a subsequent increase in ultra-processed foods (high in sugar, cholesterol, and saturated fats). Those who experienced depression from a traumatic event in their life were more likely to increase body weight during the lockdown because of a rise in number of daily meals and lowered water intake.
Casas et al. (2022)	Spain	945 (71)	43.4 ± 13.4	MEDAS	Most participants had a high MD adherence during confinement. Around one third of participants increased the amount of food intake and 40% reduced snacking between meals. With regards to weight change, 46% maintained the same weight, one third had weight gain and the rest experienced weight loss.
Censi et al. (2022)	Italy	1027 (47)	N/A	KIDMED	Only a third of the participants had a high adherence to the diet, with younger age groups (2–5 years) having better scores. Overall, eating habits resembled the Western diet during confinement. Around 78% of the children halted their physical activity, ages 6–11 showing the higher percentage.

(continued)

Table 2. (continued)

Author, Year	Ethnicity	Total participants (% female)	Mean age (years)	Tool used to assess MD adherence	Main findings
Cheikh Ismail et al. (2020)	United Arab Emirates	1012 (76)	N/A	Short FFQ	Participants showed overall increased intake in homemade food and a decreased intake of fast-food. Participants ate breakfast and drank water more often during the pandemic and skipped less meals due to more time at home. However, the components of meals resembled the Western diet, rather than the traditional MD for most participants.
Cirillo et al. (2021)	Italy	140 (100)	39.4 ± 5	Untitled questionnaire	Adherence to the MD decreased during confinement. There was increased consumption of meat, cheese and sweets attributed to boredom, while consumption of fruits and vegetables decreased.
Cobos-Palacios et al. (2021)	Spain	158 (77)	72.21 ± 5.04	N/A	Results demonstrated that both Young-Old and Old-Old groups had an overall increased their adherence to the MD after intervention but reduced their physical activity and had worse mental health. Both groups consumed a higher intake of vegetables, fruits, legumes, fish, lean meats, nuts and olive oil with reduced consumption of red meat, sugary drinks, processed foods and butter. The Old-Old group, however, had a higher consumption of carbohydrates and fibre during the 12 months.
Di Renzo et al. (2020)	Italy	3533 (76)	36.0 ± 9.0	EHL-COVID-19 questionnaire	There was increased intake of various components of the MD, in particular vegetables and legumes, accompanied by a decrease in non-Mediterranean foods. 17.7% and 34.4% of participants reported feeling decreased and increased satiety, respectively.
Di Santo et al. (2020)	Spain	126 (81)	74.3 ± 6.5	MEDAS	Around a third of participants showed decreased adherence to the MD and weight gain.
Docimo et al. (2021)	Italy	220 (51)	9.1 ± 2.9	KIDMED Index	High adherence to the MD was shown in only 18.6% of participants. During the pandemic, increases were seen in the number of meals and sweets consumed, leading to increased risk factors for dental caries.
Dragun et al. (2020)	Croatia	1857 (63)	18 ± 6.0	Untitled questionnaire	Participants (medical students) reported increased intake of fish, fruit and legumes and decreased intake of dairy, nuts and cereals. A third of participants also lost weight during the lockdown period. Adherence to the MD was associated with better quality of life and happiness, and with decreased mobile phone and TV usage.
Franco et al. (2021)	Spain	297 (50)	42.76 ± 7.79	PREDIMED	Overall, there was an increased adherence to the MD among Spanish office employees. Interestingly, there was an increase in both physical activity and sedentary habits during the pandemic.
Galali (2021)	Iraq	2137 (56)	N/A	EBL-COVID 19	Most participants (56.2%) showed moderate adherence to the MD during lockdown, while only 3.5% showed high adherence. Overall, there was an increase in homemade food consumption, including both healthy and unhealthy foods.
Galluccio et al. (2021)	Italy	91 (46)	16.60 ± 1.28	DIMENU	There was no significant difference in pre- and post-pandemic dietary habits. Active

(continued)

Table 2. (continued)

Author, Year	Ethnicity	Total participants (% female)	Mean age (years)	Tool used to assess MD adherence	Main findings
García-Esquinas et al. (2021)	Spain	3041 (58)	74.5	MEDAS	adolescents had a higher adherence to the MD than sedentary ones. However, there is still a significant gap between the reported dietary habits and ideal habits. The lockdown overall, did not cause a decline in lifestyle risk factors (diet, alcohol intake, weight or smoking) but showed an increase sedentary time and a reduced physical activity. These were reversed at the end of lockdown. People who adhered well to the MD and exercised were protected against developing unhealthier habits during lockdown. The same cannot be said for males, elderly, people with chronic morbidities and those with a high social isolation.
Gerini et al. (2022)	Italy	1228 (N/A)	N/A	Untitled questionnaire	During the pandemic, there was an overall increase in food consumption which was consistent with information found in other studies. However, a simultaneous increase of calorie dense food such as sweets and snacks was observed apart from increased vegetable and fruit intake. This illustrated progressive worsening in adherence to the MD among US and Italian participants and coupled with reduced physical activity, leads to weight gain.
Grant et al. (2021)	Italy	2678 (52)	N/A	PREDIMED PLUS	Most participants showed low adherence to the MD pre-confinement, which improved significantly during confinement. While the consumption of fruit, vegetables, legumes and fish increased, there was also an increased consumption of sugary foods.
Green (2021)	Israel	212 (N/A)	26.23 ± 6.36	Untitled questionnaire	Novice nursing students had better dietary habits than advanced and senior ones. Furthermore, knowledge regarding the MD displayed a positive indirect effect on consumption patterns through subjective nutritional knowledge.
Hanani et al. (2022)	Palestine	329 (N/A)	19.5 ± 1.4	MEDAS	In terms of adherence to the MD; 24.5% of participants were highly adherent to the MD during confinement, 63.3% were moderately adherent, whilst only 11.2% were minimally adherent.
Izzo et al. (2021)	Italy	1519 (72)	7.4 ± 1.8	MEDAS	Most participants showed moderate adherence to the MD during lockdown (73.5%), followed by low adherence (14.7%) and high adherence (11.7%). Whilst there was increased consumption of nuts, legumes and vegetables, the consumption of fruit and vegetables was overall below the recommended amounts.
Kendel Jovanović et al. (2021)	Croatia	1370 (53)	12.72 ± 1.17	KIDMED	Overall, there was a significant decrease in MD adherence and physical activity, accompanied by weight gain.
Karam et al. (2022)	Lebanon	1030 (68)	N/A	MedDiet Score	Less than half of participants (39.2%) had higher-than-adequate MD adherence during the pandemic. Increased MD adherence was associated with exercising three or more times per week, living in Northern provinces, older age and tertiary educational level.
	Israel	3797 (76)	N/A	I-MEDAS	Over half of participants stated that their diet before the pandemic was overall

(continued)

Table 2. (continued)

Author, Year	Ethnicity	Total participants (% female)	Mean age (years)	Tool used to assess MD adherence	Main findings
Kaufman-Shriqui et al. (2021)					healthier than what their diets consists of now. 30% of participants stated that they observed no change in their diet and the remainder stated that their diet had improved during the pandemic. Change in weight was reported in 37.2% of participants and of these, 67.8% stated that there was weight gain while the rest saw weight loss.
Kolokotroni et al. (2021)	Cyprus	745 (74)	39	MEDAS	There was moderate adherence to the MD during lockdown but around 30% of the participants had a higher score. There was increased consumption of both healthy (vegetables, fruits and legumes) and unhealthy (sweets and soft drinks) foods.
Kyprianidou et al. (2021)	Cyprus	1485 (N/A)	36 ± 12	MedDiet Score	This study included a total of 1485 participants from all areas of Cyprus. Adherence to the MD during lockdown was more likely in males and married people and was less likely in unmarried people and smokers.
Lotti et al. (2022)	Italy	653 (64)	N/A	Medi-Lite	Overall, adherence to the MD significantly increased during confinement, with a particular increase in the consumption of pasta, legumes and vegetables.
Magnano San Lio et al. (2022)	Italy	1198 (100)	N/A	FFQ	Overall, participants had reduced adherence to the MD during the pandemic, when compared to before the pandemic. Reduced amounts of fruits, vegetables, legumes, dairy and fish were consumed during the pandemic.
Mariscal-Arcas et al. (2021)	Spain	936 (45)	N/A	Untitled questionnaire	Throughout lockdown, the participants adhered very well to the MD because of the adequate consumption of legumes, vegetables, fruits, fish, meat, dairy foods and eggs. There seemed to be an increased interest in practising good health, so much so that having snacks between meals and consumption of processed foods like soft drinks and sweets was avoided.
Mastorci et al. (2021)	Italy	1289 (52)	12.53 ± 1.25	KIDMED	During the lockdown, participants showed a higher adherence to the MD.
Mieziene et al. (2022)	Croatia, Lithuania	1388 (64)	N/A	MEDAS	There was no statistically significant difference in eating habits between Croatian university students (Mediterranean country) and Lithuanian university students (non-Mediterranean country). Over half of participants exhibited low MD adherence.
Mohajeri et al. (2021)	Iran	2540 (N/A)	N/A	MEDAS	There was an overall increase in adherence to MD diet because of a higher consumption of vegetables, fruits, legumes, and nuts with the following percentages showing consumption of these food groups during lockdown: 71.85%, 60.70%, 24.72% and 14.33% respectively
Molina-Montes et al. (2021)	Spain	36,185 (77.6)	N/A	MEDAS	Results showed that adults from 16 European countries adopted a healthier diet during the pandemic as reflected by a rise in MD adherence. Most prominent adherence was observed in Portugal, Spain, Greece and Italy. 52.1% of participants increased home cooking during lockdown and 57.8% decreased consumption of fast food.
Morales Camacho et al. (2021)	Colombia	266 (53.4)	8.5 ± 2.04	KIDMED	Children developed the habit of having breakfast every morning of the day, whilst also adding legumes in their meals more than once a week and eating pasta or rice every

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Table 2. (continued)

Author, Year	Ethnicity	Total participants (% female)	Mean age (years)	Tool used to assess MD adherence	Main findings
Papadaki et al. (2022)	Greece	2088 (49)	15.07 ± 1.46	KIDMED	day. It was found that only 12% of children had high adherence to the MD. Being less than 9 years old is associated with high adherence and having female High MD adherence was observed in only 9.1% of participants. High MD adherence during lockdown was associated with higher health-related quality of life perception among participants.
Pérez-Rodrigo et al. (2021)	Spain	1155 (71)	N/A	Short FFQ	Change in food consumption during confinement was assessed according to traditional food groups. Firstly, participants showed increased consumption of unhealthy snack foods and beverages, as well as increased consumption of fresh and cooked fruit, legumes and vegetables. There was also a higher consumption of dairy products, meat and fish, but to a lesser extent, eggs. Consumption of carbohydrates (e.g., rice and pasta) also increased.
Pfeifer et al. (2021)	Croatia	4281 (80)	N/A	MEDAS	Most participants maintained similar diets before and during the lockdown. However, over half of the participants increased intake of homemade food. Adherence to the MD was mostly seen in younger females with normal BMI and a high educational level. Higher adherence to the MD was associated with increased physical activity.
Prete et al. (2021)	Italy	604 (72)	29.8 ± 10.4	QueMD	Around 63% of participants had an overall low adherence to the MD, and 67% increased consumption of sugary foods. Around 55% of participants reported no change in the amount of carbohydrates, fish, meat and olive oil consumed.
Rodríguez-Pérez (2020)	Spain	7514 (71)	N/A	MEDAS	Overall, there was a statistically significant increase in adherence to the MD during the lockdown period.
Romero-Blanco et al. (2020)	Spain	312 (81)	20.5 ± 4.56	PREDIMED	Eating habits that were ingrained in the participants (health science students) did not change significantly throughout the lockdown. Participants who followed a MD experienced increased minutes of daily sitting, although weekly patterns of physical activity also increased.
Sánchez-Sánchez et al. (2020)	Spain	1073 (73)	38.7 ± 12.4	PREDIMED	Adherence to the MD increased during the lockdown period, however, unhealthy food consumption also increased. Overall, duration of exercise decreased.
Sulejmani et al. (2021)	Kosovo	689 (71)	N/A	MEDAS	There was evidence that family home residents, females, people from Gjiilan and those with professional educations had a higher adherence to the MD. Decreased consumption of meat and fish, increased cooking frequency and fast-food consumption led to weight gain during lockdown.
Taeymans et al. (2021)	Switzerland	821 (N/A)	N/A	bMDSC	Only 0.9% of participants were fully adherent to the MD. Nutrition/dietetics majors were more adherent to the MD than other health science students. Most respondents reported no alcohol, beer or spirit consumption in the preceding

(continued)

Table 2. (continued)

Author, Year	Ethnicity	Total participants (% female)	Mean age (years)	Tool used to assess MD adherence	Main findings
Turki et al. (2022)	Tunisia	1082 (74)	32.5 ± 12.0	MEDAS	week, whilst only 0.2% of participants report drinking excessive amounts of alcohol (>7 units per day). Overall MD adherence was medium-low during lockdown. High MD adherence was associated with age, profession, household welfare proxy and location, with participants from centre-east Tunisia showing the highest adherence.
Umakanthan and Lawrence (2022)	Germany	2029 (75)	38.9 ± 11.3	MEDAS	Those who adhered to Covid-19 prevention measures had better adherence to the MD. This study demonstrated that those with healthier eating habits, overall have better health behaviours.
Ventura et al. (2021)	Spain	3464 (48)	N/A	KIDMED	This study included individuals <17 years of age, of whom 53.2% showed optimal adherence to the MD, with children under 6 years having the highest adherence.
Villodres et al. (2021)	Spain	899 (54)	N/A	KIDMED	This study included a total of 899 pre-adolescent participants. There was no significant difference between the degree of MD adherence before and during the pandemic, except in the first year of secondary education, where MD adherence was higher during lockdown.
Case-control studies					
Biviá-Roig et al. (2022)	Spain	102 (33)	45.5 ± 11.8	MEDAS	Whilst there was no significant difference in the participants' diet, this study justifies the need of programs to reduce depression and anxiety and improve lifestyle for potential future pandemics.
Bonaccio et al. (2022a)	Italy	4400	N/A	MedCovid-19 Score	Participants showed an overall increased adherence to the MD during the confinement period. This was associated with increased wealth, education and male sex.
Cinque et al. (2022)	Italy	357 (33)	61 ± 12	Untitled questionnaire	All participants were diagnosed with NAFLD. Before the lockdown, 56% of the participants were following a balanced MD, which reduced to around 50% after lockdown. With regards to weight change, after the lockdown there was 48% who had a increase in body weight, 35% who lost weight and 17% whose weight remained the same.
Grabia et al. (2021)	Poland	219 (N/A)	N/A	MEDAS	Whilst no participant was fully adherent to the MD, the majority of those with T1DM (cases) and non-T1DM (controls) were moderately adherent. Diabetics had significantly higher consumption of fruits, vegetables, meat, butter, oil and seafood.
Prospective studies					
Bartlett et al. (2021)	Australia	1671 (73)	63.4 ± 7.17	Untitled questionnaire	Results showed increased consumption of snacks and weight gain during the lockdown, however, there was a slight improvement in adherence to the MD.
Ben Hassen et al. (2022)	Qatar	356 (42)	N/A	Untitled questionnaire	During the COVID-19 pandemic, 45.5% of participants ate healthier diets with increased consumption of fruits and vegetables. 42.4% chose healthier foods and 53.1% reduced the number of unhealthy foods.
De Amicis et al. (2022)	Italy	463 (83.37)	52.5	MEDAS	The confined group demonstrated improved adherence to the MD and a decrease in

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Table 2. (continued)

Author, Year	Ethnicity	Total participants (% female)	Mean age (years)	Tool used to assess MD adherence	Main findings
Fatenza et al. (2022)	Italy	Adults: 123 (82.6) Children 73 (49%)	Adults: 43.4 ± 0.5 Children: 11.5 ± 0.3	Adults: Medi Lite Questionnaire Children: KIDMED Questionnaire MEDAS	food addiction and binge eating behaviour. The fact the telemedicine was used may have aided in this improvement since it increased the link between healthcare professionals and participants during lockdown. Therefore, a well monitored weight loss program was beneficial in reducing weight gain during COVID. Adults gained weight in view of decreased physical activity and more hours dedicated to sleep, whilst the children gained weight due to secondarily changes in diet. A high percentage of adults and children did not perform regular exercise during lockdown was also noticed. Children showed mostly the direct correlations between dietary changes and BMI. This included decreased consumption of fresh fruit, fish and increase in cereals, carbohydrates, dairy and olive oil. Results showed that around 30% of participants were eating more meals, snacks, gaining weight and performing fewer physical activities during the lockdown. This could be because residents more time at home, leading to increased cooking frequency and a higher degree of emotional eating. Women were more likely to be affected than men in this study.
Giacalone et al. (2020)	Denmark	2462 (71.1)	N/A		Results showed that MD adherence among healthcare students increased and that this was due to more consumption of fruits, olive oil, nuts and vegetables. Physical activity was increased as well.
Imaz-Aramburu et al. (2021)	Spain	267 (76)	20.09 ± 4.04	Untitled questionnaire	Participants were divided into unhealthy and healthy lifestyle groups. Both groups involved exhibited worsening of cholesterol, HDL and isometric knee extension strength parameters during confinement. In particular, the former group displayed a worsening in LDL and non-HDL lipids, fat mass/height, truncal fat mass, total fat mass, bone mineral density of femoral neck and handgrip strength.
Marcos-Pardo et al. (2022)	Spain	30 (100)	64.43 ± 4.58	PREDIMED	While adherence to the MD increased during lockdown, physical activity decreased and screen time increased. Therefore, there was an overall decline in health during lockdown.
Medrano et al. (2021)	Spain	291 (48)	12.1 ± 2.1	KIDMED	A substantial proportion of the participants (38.8%) reported increased adherence to the MD and locally grown produce, which was associated with wealth and older age.
Ruggiero et al. (2021)	Italy	3161 (60)	57.7 ± 15.4	ALT RISCOVID-19/ Moli-LOCK	The majority of participants (55%) reported weight gain during the lockdown period. The same individuals also reported increased frequency of meals, less physical activity and lower adherence to the MD.
Shanmugam et al. (2021)	Various	494 (61)	33.4 ± 0.58	Untitled questionnaire	Participants maintained the same level of consumption of vegetables, fruits, fish, legumes, starches, white and red meat. The frequency of cooking was increased during the lockdown but there was decreased consumption of sugary drinks, low alcoholic drinks and spirits. Around 80% of participants were adherent to the MD.
Sumalla-Cano et al. (2022)	Spain	168 (67)	N/A	MEDAS	

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Table 2. (continued)

Author, Year	Ethnicity	Total participants (% female)	Mean age (years)	Tool used to assess MD adherence	Main findings
Randomised-controlled studies					
Arrieta-Bartolomé et al. (2022)	Spain	81 (17)	57.2 ± 11.6	MDS	MDS scores for the MD showed a significant increase from pre- to post-cardiac Rehabilitation. There was a 9% increase in individuals falling under the highly adherent category.
Gonzalez-Ramirez et al. (2022)	Spain	104 (73)	N/A	PREDIMED	The intervention group showed increased carbohydrate consumption and a decrease in fat consumption when compared to the control. During the pandemic, there were significant differences in other food groups such as fruits, vegetables, processed meat and red meat.
Natalucci et al. (2021)	Italy	30 (100)	53.5 ± 7.6	PREDIMED	After a 3-month intervention, there was an improved adherence to the MD and a reduction in BMI and body weight.
Papandreou et al. (2021)	Greece	55 (100)	49.7 ± 8.1	MedDiet Score	The intervention group received nutritional and physical activity goals and support. After three months, the intervention group showed a higher adherence to the MD than the control group, as well as a lower body fat mass and body weight. Lipid levels (LDL, cholesterol) and fasting blood glucose were elevated in the control group but remained unchanged in the intervention group.
Pérez de Sevilla et al. (2021)	Spain	23 (58)	N/A	MEDAS	Participants initially had a small adherence to MD, however, the Intervention Group showed a large improvement over time. Participants in the intervention group increased the number of fruits and vegetables eaten in a day, excluded saturated fat in the diet and limited the amount of sweets consumed.
Policarpo et al. (2021)	Portugal	97 (26)	54.6 ± 12.6	PREDIMED	There were more dramatic changes seen in the control group than in the intervention. The control group showed increased daily snack consumption and weight gain, accompanied by an increase in blood glucose levels after lockdown. The intervention group had higher MD adherence and less weight gain.
Zaragoza-Martí (2021)	Spain	51 (90)	65 ± 4.67	PREDIMED	Participants showed a significant increase in adherence to the MD during lockdown, which was maintained after confinement was lifted.

MD, Mediterranean diet; N/A, not available.

However, certain studies concluded that individuals aged over 45 years had better adherence scores compared to the younger population (Casas et al., 2022; Giacalone et al., 2020; Kyprianidou et al., 2021). This finding could be the result of the elderly perceiving their higher risk of mortality from the COVID-19 virus than other age groups, which led to their decision to stay at home and eat healthier meals (Giacalone et al., 2020). It could also be the case that with increasing age, more time was dedicated to preparation of meals, causing an increased consumption of vegetables, fruits, and legumes (Álvarez-Gómez et al., 2021).

Regarding the paediatric and adolescent populations, most studies showed that older children (10–15 years) had a better adherence to the MD, which might imply that parents were more conscious of the ongoing crisis and opted to cook more traditional MD meals (Mastorci et al., 2021; Kenđel Jovanović et al., 2021). Indeed, one study listed that this high adherence could be attributed to spending more time at home eating home-cooked meals instead of fast food. Most parents also spent more time at home due to teleworking, which translated to taking better care of their diet and buying less snacks and sweets (Kenđel Jovanović et al., 2021). Two studies revealed that better adherence was observed between the ages of 2–5 years (Ventura et al., 2021; Censi et al., 2022). Censi et al. (2022) reported that only a third of the participants had an optimal KIDMED score. A diet with poor quality may interrupt growth and development of the child and can lead to increased risk of chronic diseases appearing later on in life (Shenkin, 2006).

Variance in Mediterranean diet adherence by sex

Females appeared to adhere to the MD less when compared to their male counterparts (Ben Hassen et al., 2022; Boaz et al., 2021; Bonaccio et al., 2022b; Cheikh Ismail et al., 2020; Cirillo et al., 2021; Izzo et al., 2021; Kyprianidou et al., 2021; Sumalla-Cano et al., 2022). Before the pandemic, Boaz et al. (2021) found that both sexes abided by a healthy diet. However, significantly more women than men had a worsening in diet quality during the pandemic due to increased consumption of Western dietary components, such as pastries, cheese and meat instead of vegetables, fruits and legumes (Boaz et al., 2021). This was often coupled with increased frequency of daily meals, which can lead to obesity (Cheikh Ismail et al., 2020).

Conversely, some studies found that males were less adherent to the MD than females. According to El Khoury and Julien (2021), men reduced their intake of vegetables, rice and pasta and replaced them with fried potatoes, chips, fish, alcohol, red meat and poultry. Another study found that male participants were consuming more sweets than the female participants, even though females skipped breakfast frequently and ate a higher variety of snacks (Izzo et al., 2021). García-Esquinas et al. (2021), reported that older males tend to be socially isolated or feel lonely, live in poor housing conditions

and those suffering from chronic morbidities have an increased risk of decreasing adherence to the MD during lockdown due to their increased vulnerability to restrictions. Nonetheless, at least six studies concluded that there were no significant differences in adherence to the MD based on sex (Álvarez-Gómez et al., 2021; Censi et al., 2022; Di Renzo et al., 2020; Prete et al., 2021; Sánchez-Sánchez et al., 2020; Ventura et al., 2021).

The main limitation in some of these studies was the fact that self-reported questionnaires were utilised, which are known to lead to self-reporting bias and recall bias (Di Renzo et al., 2020; Izzo et al., 2021; Kyprianidou et al., 2021; Sánchez-Sánchez et al., 2020; Shanmugam et al., 2021). Additionally, one of the featured studies pointed out another limitation that it had a larger proportion of female participants than males (Sánchez-Sánchez et al., 2020).

Variance in Mediterranean diet adherence by country

Spain. Spanish epidemiological studies make up the largest proportion (36%) of articles identified and reviewed. Most Spanish studies reported an overall increased adherence to the MD during lockdowns (Álvarez-Gómez et al., 2021; Arrieta-Bartolomé et al., 2022; Biviá-Roig et al., 2021; Carbayo Herencia et al., 2021; Casas et al., 2022; Cobos-Palacios et al., 2021; Franco et al., 2021; Imaz-Aramburu et al., 2021; Mariscal-Arcas et al., 2021; Medrano et al., 2021; Pérez-Rodrigo et al., 2021; Rodríguez-Pérez et al., 2020; Sánchez-Sánchez et al., 2020; Ventura et al., 2021). However, some studies noted that while MD adherence increased, the amount of unhealthy foods consumed (e.g., sugary drinks) also increased. Moreover, individuals became more sedentary and exercised less (Pérez-Rodrigo et al., 2021; Sánchez-Sánchez et al., 2020). One study also reported an increase in anxiety and smoking levels (Biviá-Roig et al., 2021). A substantial number of studies reported minimal changes in MD adherence during lockdown (Bagues et al., 2021; Biviá-Roig et al., 2020; Romero-Blanco et al., 2020; Sumalla-Cano et al., 2022; Villodres et al., 2021), while only three studies reported an overall decreased adherence (Di Santo et al., 2020; Marcos-Pardo et al., 2022; Morales Camacho et al., 2021). Of note, all three Spanish randomised-controlled trials that were conducted during lockdown periods reported a significant improvement in participants' dietary habits in the intervention group (García Pérez de Sevilla et al., 2021; Gonzalez-Ramirez et al., 2022; Zaragoza-Martí et al., 2021). These individuals were provided with a personalised diet and exercise plan, and in some cases, a personal trainer. This emphasises the importance of professional support during challenging times to encourage healthier habits in the general population.

Italy. Italian epidemiological studies make up the second largest proportion (26%) of articles identified and reviewed.

Unlike their Spanish counterparts, an overall trend in MD adherence cannot be deduced from the Italian studies. Seven studies reported an increased adherence to the MD during lockdowns, particularly homemade foods (Bonaccio et al., 2022b; De Amicis et al., 2022; Di Renzo et al., 2020; Grant et al., 2021; Lotti et al., 2022; Mastorci et al., 2021; Ruggiero et al., 2021). This was associated with older age, increased wealth, and male sex (Bonaccio et al., 2022b). However, three studies reported no change in MD adherence (Cinque et al., 2022; Galluccio et al., 2021; Izzo et al., 2021) and seven reported decreased adherence, with increased consumption of processed and sugary foods attributable to boredom (Bonaccio et al., 2022a; Censi et al., 2022; Cirillo et al., 2021; Docimo et al., 2021; Gerini et al., 2022; Magnano San Lio et al., 2022; Prete et al., 2021). Variance may be due to cultural differences between Italy's geopolitical regions. In fact, one study that included participants from various geopolitical regions reported that Northern and Central regions showed healthier lifestyle habits, as evidenced by lower BMIs, when compared to Southern regions (Di Renzo et al., 2020).

Eastern European countries. The two Cypriot epidemiological studies are in accordance with each other and report mild increases in MD adherence during lockdown. Individuals that were residing in rural areas, unmarried, male, and physically active were more likely to be adherent to the MD (Kolokotroni et al., 2021; Kyprianidou et al., 2021). Meanwhile, the Croatian population experienced a decrease in MD adherence during lockdown (Kendel Jovanović et al., 2021; Pfeifer et al., 2021), with the exception of a select subpopulation of medical students, who showed improved dietary habits and physical activity (Dragun et al., 2020), suggesting that this behavioural pattern may be influenced by their education. A study from Kosovo reported increased MD adherence in females, especially those with higher educational attainment. However, a significant proportion of participants experienced weight gain due to additional meals and unhealthy snacks consumed (Sulejmani et al., 2021). Interestingly, Polish females with type 1 diabetes mellitus were consuming more fruit, vegetables, and seafood than their non-diabetic counterparts during lockdowns (Grabia et al., 2021).

Middle eastern countries. Most Palestinian medical students were moderately adherent to the MD (63.3% of study population) during lockdown, with the majority more likely to be engaged in physical activity, longer sleep duration and less screen time than the rest of the study population. In this study, MD adherence was not significantly associated with mental health, while physical activity and sleep were significantly associated (Hanani et al., 2022). An Iraqi study reported increased consumption of both healthy and unhealthy foods during lockdown, with most participants

being moderately adherent to the MD. However, around half of participants reported a deterioration in lifestyle during the pandemic and a third of participants reported weight gain (Galali, 2021). An Israeli study revealed that 60% of participants experienced a deterioration in dietary habits, with 25% of participants experiencing weight gain and only 17% experiencing weight loss. Poor diet and weight gain were associated with increased odds of experiencing anxiety during confinement (Kaufman-Shriqui et al., 2021). In the United Arab Emirates, participants shifted towards Western dietary components during lockdowns (Cheikh Ismail et al., 2020). In contrast, Omani adults were found to improve their dietary habits during lockdowns, with 51.3% reducing their intake of unhealthy foods. Participants were inclined to buy from local food sources online and did not stockpile items (Ben Hassen et al., 2021).

Discussion

While a mixture of positive and negative lifestyle changes were observed during the COVID-19 pandemic, it seems that the majority of epidemiological studies discussed in this review reported reduced adherence to the MD. In a considerable proportion of these studies, reduced MD adherence was associated with other negative habits, such as increased screen time and reduced physical activity. This coincided with other dietary habits reported. In fact, a quantitative cross-sectional study from Turkey (Coşkun et al., 2022) reported weight gain in 59.1% of participants working from home during the lockdown period. Additionally, weight gain was associated with higher work hours, daily sedentary time and Non-Healthy Diet Index scores. Similar findings were seen in some of the studies featured in this review, where decreased MD adherence was associated with reduced physical activity (Izzo et al., 2021; Karam et al., 2022), increased screen time (Cheikh Ismail et al., 2020; Medrano et al., 2021) and increased anxiety levels (Biviá-Roig et al., 2022; Bonaccio et al., 2022a).

In contrast, an American qualitative study (Orr et al., 2022) reported improvements in females' diet during lockdown, despite decreased sleep quality and increased stress. Interestingly, participants reported stress and poor sleep quality as the key factors that led them to improve their diets; hence, the importance of managing stress as part of a holistic lifestyle intervention. The trends in food consumption during the pandemic can be further highlighted using artificial intelligence technology. A study by Eftimov et al. (2020) analysed the type of recipes added to a popular food website during the lockdown period. Results showed dramatic increases in recipes containing pulses, soup and tortillas, as well as moderate decreases in recipes containing fish, grains and wine. These findings support the notion that individuals may have tried to use the lockdown as a chance to improve their dietary habits, as was also seen in some of the studies in this review

(Dragun et al., 2020; Kaufman-Shirqui et al., 2021; Hanani et al., 2022).

Several international health organisations issued dietary recommendations during the first wave of the COVID-19 pandemic. In general, it is established that there is no single supplement that can reliably prevent or treat COVID-19 infection (Associação Brasileira de Nutrologia, 2020). However, it is recommended that individuals obtain a variety of micronutrients from food and vitamin D from graded sun exposure. In addition, at risk groups (e.g., breastfeeding mothers, chronically ill) may benefit from supplements during the pandemic (Centers for Disease Control and Prevention, 2021). With regards to meals consumed, it is ideal for individuals to purchase fresh produce in favour of processed foods, in addition to using less oil and sugar when preparing meals (American Society for Nutrition, 2020).

When devising public health strategies, it is important to consider additional factors influencing nutrition that transcend the individual. On a community level, food may be unequally distributed between households, which disproportionately affects lower socioeconomic classes. This may be due to the 'panic-buying' and 'stock-piling' phenomena in response to fear of food shortages, which inevitably contributes to increased shortages, especially among those who cannot afford to buy in bulk (Timmer, 2010; Vo and Thiel, 2006). The latter population includes the elderly, frail and chronically ill, in whom nutritional deficiencies may have devastating health effects (Bialek et al., 2020). On a national level, increased economic uncertainty and altered consumer behaviours during pandemics make it increasingly difficult to keep up with the demand (Vo and Thiel, 2006). On a global level, pandemics bring about altered patterns of food distribution and shipping, which invariably affects all areas dependent on land, air and sea transportation of goods, especially across international borders (Gostin, 2006).

In reality, the COVID-19 pandemic delivered a blow to the dietary aspect of Mediterranean lifestyle that has been in steady decline during recent decades. A recent study by Quarta et al. (2021) reported moderate-to-weak MD adherence in Southern European countries, which are traditionally Mediterranean countries. Only 11% of participants were in the highly adherent group, while over half of participants were in the minimally adherent group. This level of MD adherence was only slightly higher than that obtained by non-Mediterranean Balkan countries in the same study. However, olive oil was still the main source of fat in the Mediterranean countries. The shift of women from following traditional domestic roles to being part of the workforce, as well as the fast-paced modern lifestyles may be important contributors to the abandonment of the MD (Patino-Alonso et al., 2014). Several studies note that older females that occupy more traditional roles show increased adherence to the MD when compared to younger females (Kontogianni et al., 2008; Sanchez-Villegas et al., 2002). Interestingly, a Moroccan study showed no

significant differences in MD adherence between males and females. This could be due to the fact that female participants occupied more traditional roles and spend more time preparing meals (Bedmar, 2011).

Similar findings emerged in this review, as overall, decreased MD adherence was seen mostly in young females (Ben Hassen et al., 2022; Boaz et al., 2021), whilst higher MD adherence was more likely in the older age groups (Casas et al., 2022; Giacalone et al., 2020). When compared to men, women are more likely to be emotional eaters, thus resulting in increased unhealthy food consumption out of fear, boredom, or anxiety (Waller and Osman, 1998). Additionally, women who had the added responsibility of household maintenance might have turned to food as a coping mechanism (Spoor et al., 2007). It is known that prolonged stress leads to increased cortisol levels, which in turn leads to increased feeling of hunger (Ben Hassen et al., 2021; Sumalla-Cano et al., 2022). Increased stress among Spanish university students was associated with decreased MD adherence, especially in females and in those with subjects requiring communication of own ideas (Chacón-Cuberos et al., 2019). Studies in this systematic review report mixed levels of MD adherence among university students and individuals of higher educational attainment (Dragun et al., 2020; Hanani et al., 2022; Taeymans et al., 2021). Therefore, further investigation is needed into the specific cultural societal factors associated with MD decline. This being said, public health strategies need to consider the root cultural causes of decreased MD adherence, apart from acute exacerbation by a public health emergency.

The epidemiological studies in this review have varying strengths and limitations. Most studies were able to gather a large number of participants due to the use of online questionnaires. While this is associated with improved generalisability, there is limited expression of individual experiences and elaborated responses. Moreover, self-reported questionnaires are subject to self-reported bias and recall bias (Di Renzo et al., 2020; García-Esquinas et al., 2021; Grant et al., 2021; Pfeifer et al., 2021). Some studies included questionnaires in different languages to cater to a multilingual population, which may improve response accuracy. However, variation between languages may result in differences in interpretation by participants, hence, requiring laborious validation processes (Cheikh Ismail et al., 2020). Some countries, such as Spain and Italy, featured in multiple studies. This is beneficial as it provides a greater understanding of the overall trends in that country and any variances between regions.

The strengths and limitations of the reviewed epidemiological studies in part depend on the tool used to assess MD adherence. These tools have several common strengths, chiefly, ease of administration, low-cost and proven validity. However, common limitations when using self-reported questionnaires are non-response bias, acquiescence bias and recall bias. The most popular tools to assess MD adherence in adults were the Mediterranean Diet Adherence Screener

(MEDAS) and its international variant (I-MEDAS). MEDAS and I-MEDAS are composed of 14 and 11 questions, respectively, relating to the core food groups consumed as part of the MD. Since MEDAS was designed for use by adults in Mediterranean countries, it has limited applicability in non-Mediterranean regions and in children (Schröder et al., 2011). However, I-MEDAS can be used in the latter scenarios (Abu-Saad et al., 2019). Other commonly used tools include the Food Frequency Questionnaire (FFQ), which utilises a list of foods and assesses the frequency and amount of consumption (Resnicow et al., 2000), as well as Medi-Lite (Gnagnarella et al., 2018) and QueMD (Sofi et al., 2017), which relate to the frequency of consumption of core food groups of the Mediterranean diet. These have similar strengths and limitations to the MEDAS questionnaire. A popular tool to assess MD adherence in children was the KIDMED questionnaire, which is specifically designed for use in children and adolescents (Serra-Majem et al., 2004).

The main limitation of this study is it being a narrative systematic review, rather than a meta-analysis. Hence, statistical data from the reviewed epidemiological studies have not been re-analysed and combined. Instead an in-depth view and discussion of the general findings from each study was provided. While every effort has been made to capture all the relevant epidemiological studies, some may have been missed by the search strategy employed.

Conclusion

While varying dietary patterns are seen among different populations, the large proportion of individuals experiencing decreased adherence to the MD is of concern. Increased boredom, anxiety and screen time are all factors that have been reported as possible causes for the increase in appetite and ‘comfort foods’ consumed during confinement. As noted in interventional studies, individuals having support from professionals showed improved dietary habits during lockdowns. Therefore, professional support is of utmost importance in scenarios of public health emergencies so that individuals avoid behaviours that are detrimental to their health.

Authors' contributions

Conceptualisation, FF.; methodology, FF, DB, DR.; formal analysis, FF, DB, DR.; resources, SC.; data curation, FF, SC.; writing – original draft preparation, FF, DB, DR.; writing – review and editing, SC.; visualization, FF, SC.; supervision, SC.

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Supplemental material

Supplemental material for this article is available online.

References

- Abu-Saad K, Endevelt R, Goldsmith R, et al. (2019) Adaptation and predictive utility of a Mediterranean diet screener score. *Clinical Nutrition* 38(6): 2928–2935.
- Adhanom Ghebreyesus T (2020) WHO Director-General's opening remarks at the media briefing on COVID-19 – 11 March 2020. Available at: <https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19—11-march-2020> (accessed 28 August 2022).
- Alfonso Viguria U and Casamitjana N (2021) Early interventions and impact of COVID-19 in Spain. *International Journal of Environmental Research and Public Health* 18(8): 4026.
- Álvarez-Gómez C, De La Higuera M, Rivas-García L, et al. (2021) Has COVID-19 changed the lifestyle and dietary habits in the Spanish population after confinement? *Foods* 10(10): 2443.
- American Heart Association (2020) What is the Mediterranean diet? Available at: <https://www.heart.org/en/healthy-living/healthy-eating/eat-smart/nutrition-basics/mediterranean-diet> (accessed 28 August 2022).
- American Society for Nutrition (2020) Making health and nutrition a priority during the coronavirus (COVID-19) pandemic. In: *American Society for Nutrition*. Available at: <https://nutrition.org/making-health-and-nutrition-a-priority-during-the-coronavirus-covid-19-pandemic/> (accessed 14 February 2023).
- Arrieta-Bartolomé G, Supervia M, Velasquez ABC, et al. (2022) Evaluating the effectiveness of a comprehensive patient education intervention in a hybrid model of cardiac rehabilitation: A pilot study. *PEC Innovation* 1: 100054.
- Associação Brasileira de Nutrologia (2020) Posicionamento da ABRAN a respeito de micronutrientes e probióticos na infecção por COVID-19. Available at: <https://abran.org.br/2020/05/01/posicionamento-da-associao-brasileira-de-nutrologia-abran-a-respeito-de-micronutrientes-e-probioticos-na-infeccao-por-covid-19/> (accessed 14 February 2023).
- Bagues A, Almagro A, Bermúdez T, et al. (2021) Adherence to the Mediterranean diet: An online questionnaire based-study in a Spanish population sample just before the COVID-19 lockdown. *Functional Foods in Health and Disease* 11(6): 283–294.
- Bartlett L, Brady JJR, Farrow M, et al. (2021) Change in modifiable dementia risk factors during COVID-19 lockdown: The

- experience of over 50 s in Tasmania, Australia. *Alzheimer's & Dementia (New York, N. Y.)* 7(1): e12169.
- Bedmar VL (2011) Educación escolar/familiar y parejas marroquíes. Estudio diacrónico de la región de Casablanca. *Foro de educación* 9(13): 139–153.
- Ben Hassen T, Bilali E, Allahyari H, et al. (2021) Observations on food consumption behaviors during the COVID-19 pandemic in Oman. *Frontiers in Public Health* 9: 779654.
- Ben Hassen T, El Bilali H, Allahyari MS, et al. (2022) Gendered impacts of the COVID-19 pandemic on food behaviors in North Africa: Cases of Egypt, Morocco, and Tunisia. *International Journal of Environmental Research and Public Health* 19(4): 2192.
- Bialek S, Boundy E, Bowen V, et al. (2020) Severe outcomes among patients with coronavirus disease 2019 (COVID-19) – United States, February 12–March 16, 2020. *Morbidity and Mortality Weekly Report* 69(12): 343–346.
- Biviá-Roig G, Boldó-Roda A, Blasco-Sanz R, et al. (2021) Impact of the COVID-19 pandemic on the lifestyles and quality of life of women with fertility problems: A cross-sectional study. *Frontiers in Public Health* 9: 686115.
- Biviá-Roig G, La Rosa VL, Gómez-Tébar M, et al. (2020) Analysis of the impact of the confinement resulting from COVID-19 on the lifestyle and psychological wellbeing of Spanish pregnant women: An internet-based cross-sectional survey. *International Journal of Environmental Research and Public Health* 17(16): E5933.
- Biviá-Roig G, Soldevila-Matías P, Haro G, et al. (2022) The impact of the COVID-19 pandemic on the lifestyles and levels of anxiety and depression of patients with schizophrenia: A retrospective observational study. *Healthcare (Basel)* 10(1): 128.
- Boaz M, Navarro DA, Raz O, et al. (2021) Dietary changes and anxiety during the coronavirus pandemic: Differences between the sexes. *Nutrients* 13(12): 4193.
- Bonaccio M, Costanzo S, Bracone F, et al. (2022a) Psychological distress resulting from the COVID-19 confinement is associated with unhealthy dietary changes in two Italian population-based cohorts. *European Journal of Nutrition* 61(3): 1491–1505.
- Bonaccio M, Gianfagna F, Stival C, et al. (2022b) Changes in a Mediterranean lifestyle during the COVID-19 pandemic among elderly Italians: An analysis of gender and socio-economic inequalities in the 'LOST in Lombardia' study. *International Journal of Food Sciences and Nutrition* 73(5): 683–692.
- Bonalumi G, di Mauro M, Garatti A, et al. (2020) The COVID-19 outbreak and its impact on hospitals in Italy: The model of cardiac surgery. *European Journal of Cardio-Thoracic Surgery* 57(6): 1025–1028.
- Brown NA, Smith KC and Kromm EE (2012) Women's perceptions of the relationship between recent life events, transitions, and diet in midlife: Findings from a focus group study. *Women & Health* 52(3): 234–251.
- Carbayo Herencia JA, Rosich N, Panisello Royo JM, et al. (2021) Influence of the confinement that occurred in Spain due to the SARS-CoV-2 virus outbreak on adherence to the Mediterranean diet. *Clinica E Investigacion En Arteriosclerosis: Publicacion Oficial De La Sociedad Espanola De Arteriosclerosis* 33(5): 235–246.
- Casas R, Raidó-Quintana B, Ruiz-León AM, et al. (2022) Changes in Spanish lifestyle and dietary habits during the COVID-19 lockdown. *European Journal of Nutrition* 61(5): 2417–2434.
- Censi L, Ruggeri S, Galfo M, et al. (2022) Eating behaviour, physical activity and lifestyle of Italian children during lockdown for COVID-19. *International Journal of Food Sciences and Nutrition* 73(1): 93–105.
- Centers for Disease Control and Prevention (2021) Coronavirus disease (COVID-19) and breastfeeding. Available at: <https://www.cdc.gov/breastfeeding/breastfeeding-special-circumstances/maternal-or-infant-illnesses/covid-19-and-breastfeeding.html> (accessed 14 February 2023).
- Chacón-Cuberos R, Zurita-Ortega F, Olmedo-Moreno EM, et al. (2019) Relationship between academic stress, physical activity and diet in university students of education. *Behavioral Sciences* 9(6): 59.
- Cheikh Ismail L, Osaili TM, Mohamad MN, et al. (2020) Eating habits and lifestyle during COVID-19 lockdown in the United Arab Emirates: A cross-sectional study. *Nutrients* 12(11): E3314.
- Cinque F, Cespiati A, Lombardi R, et al. (2022) Interaction between lifestyle changes and PNPLA3 genotype in NAFLD patients during the COVID-19 lockdown. *Nutrients* 14(3): 56.
- Cirillo M, Rizzello F, Badolato L, et al. (2021) The effects of COVID-19 lockdown on lifestyle and emotional state in women undergoing assisted reproductive technology: Results of an Italian survey. *Journal of Gynecology Obstetrics and Human Reproduction* 50(8): 102079.
- Cobos-Palacios L, Muñoz-Úbeda M, Ruiz-Moreno MI, et al. (2021) Lifestyle modification program on a metabolically healthy elderly population with overweight/obesity, young-old vs. old-old. CONSEQUENCES of COVID-19 lockdown in this program. *International Journal of Environmental Research and Public Health* 18(22): 11926.
- Coşkun MG, Öztürk Rİ, Tak AY, et al. (2022) Working from home during the COVID-19 pandemic and its effects on diet, sedentary lifestyle, and stress. *Nutrients* 14(19): 4006.
- De Amicis R, Foppiani A, Galasso L, et al. (2022) Weight loss management and lifestyle changes during COVID-19 lockdown: A matched Italian cohort study. *Nutrients* 14(14): 2897.
- Dernini S and Berry EM (2015) Mediterranean diet: From a healthy diet to a sustainable dietary pattern. *Frontiers in Nutrition* 2:15.
- Di Renzo L, Gualtieri P, Pivari F, et al. (2020) Eating habits and lifestyle changes during COVID-19 lockdown: An Italian survey. *Journal of Translational Medicine* 18: 29.
- Di Santo SG, Franchini F, Filiputti B, et al. (2020) The effects of COVID-19 and quarantine measures on the lifestyles and mental health of people over 60 at increased risk of dementia. *Frontiers in Psychiatry* 11: 578628.
- Docimo R, Costacurta M, Gualtieri P, et al. (2021) Cariogenic risk and COVID-19 lockdown in a paediatric population. *International Journal of Environmental Research and Public Health* 18(14): 7558.
- Dragun R, Veček NN, Marendić M, et al. (2020) Have lifestyle habits and psychological well-being changed among adolescents and medical students due to COVID-19 lockdown in Croatia? *Nutrients* 13(1): 97.
- Eftimov T, Popovski G, Petković M, et al. (2020) COVID-19 pandemic changes the food consumption patterns. *Trends in Food Science & Technology* 104: 268–272.
- El Khoury CN and Julien SG (2021) Inverse association between the Mediterranean diet and COVID-19 risk in Lebanon: A case-control study. *Frontiers in Nutrition* 8: 707359.

- Eriksen MB and Frandsen TF (2018) The impact of patient, intervention, comparison, outcome (PICO) as a search strategy tool on literature search quality: A systematic review. *Journal of the Medical Library Association: JMLA* 106(4): 420–431.
- Faienza MF, Colaianni V, Di Ciaula A, et al. (2022) Different variation of intra-familial body mass index subjected to COVID-19 lockdown. *Journal of Gastrointestinal and Liver Diseases* 31(2): 198–205.
- Franco E, Urosa J, Barakat R, et al. (2021) Physical activity and adherence to the Mediterranean diet among Spanish employees in a health-promotion program before and during the COVID-19 pandemic: The sanitas-healthy cities challenge. *International Journal of Environmental Research and Public Health* 18(5): 2735.
- Galali Y (2021) The impact of COVID-19 confinement on the eating habits and lifestyle changes: A cross sectional study. *Food Science & Nutrition* 9(4): 2105–2113.
- Galluccio A, Caparello G, Avolio E, et al. (2021) Self-Perceived physical activity and adherence to the Mediterranean diet in healthy adolescents during COVID-19: Findings from the DIMENU pilot study. *Healthcare (Basel, Switzerland)* 9(6): 22.
- García-Esquinas E, Ortolá R, Gine-Vázquez I, et al. (2021) Changes in health behaviors, mental and physical health among older adults under severe lockdown restrictions during the COVID-19 pandemic in Spain. *International Journal of Environmental Research and Public Health* 18(13): 7067.
- García Pérez de Sevilla G, Barceló Guido O, De la Cruz M de la P, et al. (2021) Remotely supervised exercise during the COVID-19 pandemic versus in-person-supervised exercise in achieving long-term adherence to a healthy lifestyle. *International Journal of Environmental Research and Public Health* 18(22): 12198.
- Gerini F, Fantechi T, Contini C, et al. (2022) Adherence to the Mediterranean diet and COVID-19: A segmentation analysis of Italian and US consumers. *Sustainability* 14(7): 3823.
- Giacalone D, Frøst MB and Rodríguez-Pérez C (2020) Reported changes in dietary habits during the COVID-19 lockdown in the Danish population: The Danish COVIDiet study. *Frontiers in Nutrition* 7: 592112.
- Gnagnarella P, Dragà D, Misotti AM, et al. (2018) Validation of a short questionnaire to record adherence to the Mediterranean diet: An Italian experience. *Nutrition, Metabolism and Cardiovascular Diseases* 28(11): 1140–1147.
- Gonzalez-Ramirez M, Sanchez-Carrera R, Cejudo-Lopez A, et al. (2022) Short-Term pilot study to evaluate the impact of salbi educa nutrition app in macronutrients intake and adherence to the Mediterranean diet: Randomized controlled trial. *Nutrients* 14(10): 2061.
- Gostin L (2006) Public health strategies for pandemic influenza ethics and the law. *JAMA* 295(14): 1700–1704.
- Grabia M, Puścion-Jakubik A, Markiewicz-Żukowska R, et al. (2021) Adherence to Mediterranean diet and selected lifestyle elements among young women with type 1 diabetes mellitus from northeast Poland: A case-control COVID-19 survey. *Nutrients* 13(4): 1173.
- Grant F, Scalvedi ML, Scognamiglio U, et al. (2021) Eating habits during the COVID-19 lockdown in Italy: The nutritional and lifestyle side effects of the pandemic. *Nutrients* 13(7): 2279.
- Green G (2021) Nursing students' eating habits, subjective, and Mediterranean nutrition knowledge during the COVID-19 pandemic. *SAGE Open Nursing* 7: 23779608211038210.
- Hanani A, Badrasawi M, Zidan S, et al. (2022) Effect of cognitive behavioral therapy program on mental health status among medical student in Palestine during COVID pandemic. *BMC Psychiatry* 22(1): 10.
- Hossain MM, Tasnim S, Sultana A, et al. (2020) Epidemiology of mental health problems in COVID-19: A review. *F1000Research* 9: 36.
- Imaz-Aramburu I, Fraile-Bermúdez A-B, Martín-Gamboa BS, et al. (2021) Influence of the COVID-19 pandemic on the lifestyles of health sciences university students in Spain: A longitudinal study. *Nutrients* 13(6): 1958.
- Izzo L, Santonastaso A, Cotticelli G, et al. (2021) An Italian survey on dietary habits and changes during the COVID-19 lockdown. *Nutrients* 13(4): 1197.
- Kafatos A, Verhagen H, Moschandreas J, et al. (2000) Mediterranean diet of crete: Foods and nutrient content. *Journal of the American Dietetic Association* 100(12): 1487–1493.
- Karam J, Ghach W, Bouteen C, et al. (2022) Adherence to Mediterranean diet among adults during the COVID-19 outbreak and the economic crisis in Lebanon. *Nutrition & Food Science* 52(6): 1018–1028.
- Kaufman-Shriqui V, Navarro DA, Raz O, et al. (2021) Multinational dietary changes and anxiety during the coronavirus pandemic-findings from Israel. *Israel Journal of Health Policy Research* 10(1): 28.
- Kendel Jovanović G, Dragaš Zubaļj N, Klobučar Majanović S, et al. (2021) The outcome of COVID-19 lockdown on changes in body mass index and lifestyle among Croatian schoolchildren: A cross-sectional study. *Nutrients* 13(11): 3788.
- Kolokotroni O, Mosquera MC, Quattrocchi A, et al. (2021) Lifestyle habits of adults during the COVID-19 pandemic lockdown in Cyprus: Evidence from a cross-sectional study. *BMC Public Health* 21(1): 86.
- Kontogianni MD, Vidra N, Farmaki A-E, et al. (2008) Adherence rates to the Mediterranean diet are low in a representative sample of Greek children and adolescents. *The Journal of Nutrition* 138(10): 1951–1956.
- Kyprianidou M, Christophi CA and Giannakou K (2021) Quarantine during COVID-19 outbreak: Adherence to the Mediterranean diet among the Cypriot population. *Nutrition (Burbank, Los Angeles County, Calif.)* 90: 111313.
- Lotti S, Dinu M, Pagliai G, et al. (2022) Adherence to the Mediterranean diet increased during the COVID-19 lockdown in Italy: Results from the web-based Medi-Lite questionnaire. *International Journal of Food Sciences and Nutrition* 73(5): 650–656.
- Magnano San Lio R, Barchitta M, Maugeri A, et al. (2022) The impact of the COVID-19 pandemic on dietary patterns of pregnant women: A comparison between two mother-child cohorts in Sicily, Italy. *Nutrients* 14(16): 3380.
- Marcos-Pardo PJ, Abelleira-Lamela T, González-Gálvez N, et al. (2022) Impact of COVID-19 lockdown on health parameters and muscle strength of older women: A longitudinal study. *Experimental Gerontology* 164: 111814.
- Mariscal-Arcas M, Delgado-Mingorance S, Saenz de Buruaga B, et al. (2021) Evolution of nutritional habits behaviour of Spanish population confined through social Media. *Frontiers in Nutrition* 8: 794592.
- Martínez-González MA, Salas-Salvadó J, Estruch R, et al. (2015) Benefits of the Mediterranean diet: Insights from the PREDIMED study. *Progress in Cardiovascular Diseases* 58(1): 50–60.

- Mastorci F, Piaggi P, Doveri C, et al. (2021) Health-Related quality of life in Italian adolescents during COVID-19 outbreak. *Frontiers in Pediatrics* 9: 611136.
- Medrano M, Cadenas-Sanchez C, Osés M, et al. (2021) Changes in lifestyle behaviours during the COVID-19 confinement in Spanish children: A longitudinal analysis from the MUGI project. *Pediatric Obesity* 16(4): e12731.
- Mieziene B, Burkaite G, Emeljanovas A, et al. (2022) Adherence to Mediterranean diet among Lithuanian and Croatian students during COVID-19 pandemic and its health behavior correlates. *Frontiers in Public Health* 10: 1000161.
- Mohajeri M, Ghannadiasl F, Narimani S, et al. (2021) The food choice determinants and adherence to Mediterranean diet in Iranian adults before and during COVID-19 lockdown: Population-based study. *Nutrition & Food Science* 51(8): 1299–1307.
- Molina-Montes E, Uzhova I, Verardo V, et al. (2021) Impact of COVID-19 confinement on eating behaviours across 16 European countries: The COVIDiet cross-national study. *Food Quality and Preference* 93: 104231.
- Morales Camacho WJ, Zambrano SEO, Camacho MAM, et al. (2021) Nutritional status and high adherence to the Mediterranean diet in Colombian school children and teenagers during the COVID-19 pandemic according to sex. *Journal of Nutritional Science* 10: 54.
- Natalucci V, Marini CF, Flori M, et al. (2021) Effects of a home-based lifestyle intervention program on cardiometabolic health in breast cancer survivors during the COVID-19 lockdown. *Journal of Clinical Medicine* 10(12): 2678.
- Nicolaidis S (2019) Environment and obesity. *Metabolism: Clinical and Experimental* 100S: 153942.
- Obeid CA, Gubbels JS, Jaalouk D, et al. (2022) Adherence to the Mediterranean diet among adults in Mediterranean countries: A systematic literature review. *European Journal of Nutrition* 61(7): 3327–3344.
- Orr K, Ta Z, Shoaf K, et al. (2022) Sleep, diet, physical activity, and stress during the COVID-19 pandemic: A qualitative analysis. *Behavioral Sciences* 12(3): 66.
- Papadaki S, Carayanni V, Notara V, et al. (2022) Anthropometric, lifestyle characteristics, adherence to the Mediterranean diet, and COVID-19 have a high impact on the Greek adolescents' health-related quality of life. *Foods (Basel, Switzerland)* 11(18): 2726.
- Papandreou P, Giouxari A, Nimee F, et al. (2021) Application of clinical decision support system to assist breast cancer patients with lifestyle modifications during the COVID-19 pandemic: A randomised controlled trial. *Nutrients* 13(6): 2115.
- Patino-Alonso MC, Recio-Rodríguez JI, Belio JFM, et al. (2014) Factors associated with adherence to the Mediterranean diet in the adult population. *Journal of the Academy of Nutrition and Dietetics* 114(4): 583–589.
- Pérez-Rodrigo C, Gianzo Citores M, Hervás Bárbara G, et al. (2021) Patterns of change in dietary habits and physical activity during lockdown in Spain due to the COVID-19 pandemic. *Nutrients* 13(2): 00.
- Pfeifer D, Rešetar J, Gajdoš Kljusurić J, et al. (2021) Cooking at home and adherence to the Mediterranean diet during the COVID-19 confinement: The experience from the Croatian COVIDiet study. *Frontiers in Nutrition* 8: 617721.
- Policarpo S, Machado MV and Cortez-Pinto H (2021) Telemedicine as a tool for dietary intervention in NAFLD-HIV patients during the COVID-19 lockdown: A randomized controlled trial. *Clinical Nutrition ESPEN* 43: 329–334.
- Prete M, Luzzetti A, Augustin LSA, et al. (2021) Changes in lifestyle and dietary habits during COVID-19 lockdown in Italy: Results of an online survey. *Nutrients* 13(6): 1923.
- Quarta S, Massaro M, Chervenkov M, et al. (2021) Persistent moderate-to-weak Mediterranean diet adherence and low scoring for plant-based foods across several southern European countries: Are we overlooking the Mediterranean diet recommendations? *Nutrients* 13(5): 1432.
- Resnicow K, Odom E, Wang T, et al. (2000) Validation of three food frequency questionnaires and 24-hour recalls with serum carotenoid levels in a sample of African-American adults. *American Journal of Epidemiology* 152(11): 1072–1080.
- Rodríguez-Pérez C, Molina-Montes E, Verardo V, et al. (2020) Changes in dietary behaviours during the COVID-19 outbreak confinement in the Spanish COVIDiet study. *Nutrients* 12(6): E1730.
- Romero-Blanco C, Rodríguez-Almagro J, Onieva-Zafra MD, et al. (2020) Physical activity and sedentary lifestyle in university students: Changes during confinement due to the COVID-19 pandemic. *International Journal of Environmental Research and Public Health* 17(18): E6567.
- Ruggiero E, Mignogna C, Costanzo S, et al. (2021) Changes in the consumption of foods characterising the Mediterranean dietary pattern and major correlates during the COVID-19 confinement in Italy: Results from two cohort studies. *International Journal of Food Sciences and Nutrition* 72(8): 1105–1117.
- Saglietto A, D'Ascenzo F, Zoccai GB, et al. (2020) COVID-19 in Europe: The Italian lesson. *The Lancet* 395(10230): 1110–1111.
- Salas-Salvadó J, Guasch-Ferré M, Lee C-H, et al. (2016) Protective effects of the Mediterranean diet on type 2 diabetes and metabolic syndrome. *The Journal of Nutrition* 146(4): 920S–927S.
- Sánchez-Sánchez E, Ramírez-Vargas G, Avellaneda-López Y, et al. (2020) Eating habits and physical activity of the Spanish population during the COVID-19 pandemic period. *Nutrients* 12(9): E2826.
- Sanchez-Villegas A, Martínez JA, De Irala J, et al. (2002) Determinants of the adherence to an “a priori” defined Mediterranean dietary pattern. *European Journal of Nutrition* 41(6): 249–257.
- Schröder H, Fitó M, Estruch R, et al. (2011) A short screener is valid for assessing Mediterranean diet adherence among older Spanish men and women. *The Journal of Nutrition* 141(6): 1140–1145.
- Serra-Majem L, Ribas L, Ngo J, et al. (2004) Food, youth and the Mediterranean diet in Spain. Development of KIDMED, Mediterranean Diet Quality Index in children and adolescents. *Public Health Nutrition* 7(7): 931–935.
- Shanmugam H, Di Ciaula A, Di Palo DM, et al. (2021) Multiplying effects of COVID-19 lockdown on metabolic risk and fatty liver. *European Journal of Clinical Investigation* 51(7): e13597.
- Shenkin A (2006) Micronutrients in health and disease. *Postgraduate Medical Journal* 82(971): 559–567.
- Sofi F, Dinu M, Pagliai G, et al. (2017) Validation of a literature-based adherence score to Mediterranean diet: The MEDI-LITE score. *International Journal of Food Sciences and Nutrition* 68(6): 757–762.

- Spoor STP, Bekker MHJ, Van Strien T, et al. (2007) Relations between negative affect, coping, and emotional eating. *Appetite* 48(3): 368–376.
- Sulejmani E, Hyseni A, Xhabiri G, et al. (2021) Relationship in dietary habits variations during COVID-19 lockdown in Kosovo: The COVIDiet study. *Appetite* 164: 105244.
- Sumalla-Cano S, Forbes-Hernández T, Aparicio-Obregón S, et al. (2022) Changes in the lifestyle of the Spanish university population during confinement for COVID-19. *International Journal of Environmental Research and Public Health* 19(4): 2210.
- Taeymans J, Luijckx E, Rogan S, et al. (2021) Physical activity, nutritional habits, and sleeping behavior in students and employees of a Swiss university during the COVID-19 lockdown period: Questionnaire survey study. *JMIR Public Health and Surveillance* 7(4): e26330.
- Timmer CP (2010) Reflections on food crises past. *Food Policy* 35(1): 1–11.
- Turki S, Bouzekri K, Trabelsi T, et al. (2022) Assessment of Mediterranean diet adherence and lifestyle change during COVID-19 national lockdown in Tunisian adult population. *Nutrients* 14(19): 4151.
- Umakanthan S and Lawrence S (2022) Predictors of COVID-19 vaccine hesitancy in Germany: A cross-sectional, population-based study. *Postgraduate Medical Journal* 98(1164): 756–764.
- Ventura PS, Ortigoza AF, Castillo Y, et al. (2021) Children's health habits and COVID-19 lockdown in Catalonia: Implications for obesity and non-communicable diseases. *Nutrients* 13(5): 1657.
- Villodres GC, García-Pérez L, Corpas JM, et al. (2021) Influence of confinement due to COVID-19 on physical activity and Mediterranean diet adherence and its relationship with self-esteem in pre-adolescent students. *Children (Basel, Switzerland)* 8(10): 48.
- Vo TLH and Thiel D (2006) A system dynamics model of the chicken meat supply chain faced with bird flu.
- Waller G and Osman S (1998) Emotional eating and eating psychopathology among non-eating-disordered women. *International Journal of Eating Disorders* 23(4): 419–424.
- Zaragoza-Martí A, Cabañero-Martínez MJ, Hurtado-Sánchez JA, et al. (2018) Evaluation of Mediterranean diet adherence scores: A systematic review. *BMJ Open* 8(2): e019033.
- Zaragoza-Martí A, Sánchez-SanSegundo M, Ferrer-Cascales R, et al. (2021) Effects of the Mediterranean lifestyle during the COVID-19 lockdown in Spain: Preliminary study. *Frontiers in Nutrition* 8: 683261.
- Zhu N, Zhang D, Wang W, et al. (2020) A novel coronavirus from patients with pneumonia in China, 2019. *New England Journal of Medicine* 382(8): 727–733.