Food Quality and Preference 93 (2021) 104231

Contents lists available at ScienceDirect

Food Quality and Preference

journal homepage: www.elsevier.com/locate/foodqual

Impact of COVID-19 confinement on eating behaviours across 16 European countries: The COVIDiet cross-national study

Esther Molina-Montes [a,b,c,d,1], Irina Uzhova [e,1], Vito Verardo [a,b], Reyes Artacho [a], Belén García-Villanova [a], Eduardo Jesús Guerra-Hernández [a], Maria Kapsokefalou [f], Olga Malisova [f], Antonis Vlassopoulos [f], Alexandra Katidi [f], Barbara Koroušić Seljak [g], Robert Modic [g], Tome Eftimov [g], Irena Hren [h], Eva Valenčič [g], Zvonimir Šatalić [i], Ines Panjkota Krbavčić [i], Darija Vranešić Bender [j], Davide Giacalone [k], Michael Bom Frøst [l], Aleksandra Konic Ristic [m,n], Jelena Milesevic [m], Marina Nikolic [m], Ezgi Kolay [o], Merve Güney [p], Vilma Kriaucioniene [q], Magdalena Czlapka-Matyasik [o], Aleksandra Bykowska-Derda [o], Enisa Kujundzic [r], Irzada Taljić [s], Muhamed Brka [s], Igor Spiroski [t,u], Sérgio Cunha Velho [v], Sofia Patrícia Sousa Pinto [v], Inês Nascimento Monteiro [v], Janice Adriana Pereira [v], María Dolores Ruíz-López [a,b,2], Celia Rodríguez-Pérez [b,c,w,2,*]

[a] Department of Nutrition and Food Science, University of Granada, Campus of Cartuja, 18071 Granada, Spain
[b] Institute of Nutrition and Food Technology (INYTA) 'José Mataix', Biomedical Research Centre, University of Granada, Avenida del Conocimiento s/n, E-18071 Granada, Spain
[c] Instituto de Investigación Biosanitaria ibs.GRANADA, Granada, Spain
[d] Centro de Investigación Biomédica en Red de Epidemiología y Salud Pública CIBERESP, Madrid, Spain
[e] Department of Health and Nutritional Sciences, Institute of Technology Sligo, Ash Ln, Bellanode, Sligo F91 YW50, Ireland
[f] Department of Food Science and Nutrition, Agricultural University of Athens, Iera Odos 75, Athens 11855, Greece
[g] Computer Systems Department, Jožef Stefan Institute, Jamova cesta 39, Ljubljana, Slovenia
[h] General Hospital Novo mesto, Šmihelska cesta 1, 8000 Novo mesto, Slovenia
[i] University of Zagreb, Faculty of Food Technology and Biotechnology, Pierottijeva ul. 6, 10000 Zagreb, Croatia
[j] University Hospital Centre Zagreb, Department of Internal Medicine, Division of Gastroenterology and Hepatology & Unit of Clinical Nutrition, Kišpatićeva ul. 12, 10000 Zagreb, Croatia
[k] Department of Technology and Innovation, University of Southern Denmark, Campusvej 55, DK5230 Odense, Denmark
[l] Department of Food Science, University of Copenhagen, Rolighedsvej 26, DK-1958 Frederiksberg, Denmark
[m] Institute for Medical Research, Centre of Research Excellence in Nutrition and Metabolism, University of Belgrade, National Institute of Serbia, Beograd, Tadeuša Košćuška 1, PAK 104 201, 11158 Belgrade, Serbia
[n] Institute of Food and Health, University College Dublin, Belfield, Dublin 4, Ireland
[o] Poznan University of Life Sciences, Department of Human Nutrition and Dietetics, Wojska Polskiego 28, 60-637 Poznan, Poland
[p] Bezmialem Vakif University, Medical Faculty Hospital, Nutrition and Diet Department, Vatan Cad. 34093, Istanbul, Turkey
[q] Faculty of Public Health, Lithuanian University of Health Sciences, Tilzes str. 18, LT-47181 Kaunas, Lithuania
[r] Center for Health Ecology of Institute of Public Health of Montenegro, Dzona Dzeksona bb, 81 000 Podgorica, Montenegro
[s] Faculty of Agriculture and Food Sciences, University of Sarajevo, Sarajevo, Bosnia and Herzegovina, Zmaja od Bosne 8, 71000 Sarajevo, Bosnia and Herzegovina
[t] Institute of Public Health, 50. Divizija 6, 1000 Skopje, Macedonia
[u] Faculty of Medicine, Ss. Cyril and Methodius University, 50. Divizija 6, 1000 Skopje, Macedonia
[v] Centro Hospitalar e Universitário de Coimbra, Portugal
[w] Department of Nutrition and Food Science, University of Granada, Campus of Melilla, Calle Santander, 1. 52071, Melilla, Spain

Abbreviations: COVID-19, SARS-CoV-2 coronavirus; MedDiet, mediterranean diet; MEDAS, validated 14-items mediterranean diet adherence screener; SI, stringency index; OxCGRT, Oxford COVID-19 government response tracker; SD, standard deviations.

* Corresponding author at: Department of Nutrition and Food Science, University of Granada, Campus of Melilla, Calle Santander, 1. 52071, Melilla, Spain.
E-mail address: celiarp@ugr.es (C. Rodríguez-Pérez).

[1] Joint first authors.
[2] Joint senior authors.

https://doi.org/10.1016/j.foodqual.2021.104231
Received 6 October 2020; Received in revised form 8 February 2021; Accepted 4 March 2021
Available online 23 March 2021

ARTICLE INFO

Keywords:
COVID-19 confinement
Eating behaviours
Mediterranean diet
Stringency index
Nutritional survey

ABSTRACT

We aimed to evaluate the changes in eating behaviours of the adult population across 16 European countries due to the COVID-19 confinement and to evaluate whether these changes were somehow related to the severity of the containment measures applied in each country. An anonymous online self-reported questionnaire on socio-demographic characteristics, validated 14-items Mediterranean diet (MedDiet) Adherence Screener (MEDAS) as a reference of a healthy diet, eating and lifestyle behaviours prior to and during the COVID-19 confinement was used to collect data. The study included an adult population residing in 16 European countries at the time of the survey. Aggregated Stringency Index (SI) score, based on data from the Oxford COVID-19 Government Response Tracker, was calculated for each country at the time the questionnaire was distributed (range: 0–100). A total of 36,185 participants completed the questionnaire (77.6% female, 75.2% with high educational level and 42.7% aged between 21 and 35 years). In comparison to pre-confinement, a significantly higher adherence to the MedDiet during the confinement was observed across all countries (overall MEDAS score prior to- and during confinement: 5.23 ± 2.06 vs. 6.15 ± 2.06; $p < 0.001$), with the largest increase seen in Greece and North Macedonia. The highest adherence to MedDiet during confinement was found in Spain and Portugal (7.18 ± 1.84 and 7.34 ± 1.95, respectively). Stricter contingency restrictions seemed to lead to a significantly higher increase in the adherence to the MedDiet. The findings from this cross-sectional study could be used to inform current diet-related public health guidelines to ensure optimal nutrition is followed among the population, which in turn would help to alleviate the current public health crisis.

1. Introduction

The SARS-CoV-2 coronavirus (COVID-19) pandemic has become a global health crisis affecting all aspects of the population's daily life, in particular, dietary habits and lifestyle factors were more likely to change during the COVID-19 outbreak confinement. The governmental policy responses against COVID-19 pandemic have varied considerably across different countries with respect to the restrictiveness of interventions (Chaudhry, Dranitsaris, Mubashir, Bartoszko, & Riazi, 2020), which might have affected eating behaviours across the world. A recent study including 1,047 participants mainly from Asia, Africa and Europe reported adoption of mainly unhealthy eating habits during the confinement such as eating out of control, increasing snacking or selecting less healthy foods (Ammar et al., 2020). However, it was not established whether consumption patterns changed with respect to the situation prior to that. Adherence to suboptimal diet is more likely to contribute to the development of chronic conditions which would result in the population being at the higher risk of COVD-19 pathology (Butler & Barrientos, 2020). In addition, the evidence shows an increase in mortality rate for COVID-19 with the increase in the intake of soft beverages and decreased consumption of fruits and legumes (Abdulah & Hassan, 2020). Despite the theory that directly links diet and the development/amelioration of COVID-19 symptoms is still under research, it is well-established that healthy diet plays a key role in strengthening the immune system (Iddir et al., 2020). Particular nutrients including omega-3 fatty acids, vitamins C and D and other antioxidant compounds, which are found in Mediterranean Diet (MedDiet)-derived foods such as fish, olive oil, nuts, fruits and vegetables, could support an optimal immune system function (Calder, 2020), suggesting that MedDiet might be among the healthiest diets to follow during the COVID-19 confinement (Muscogiuri, Barrea, Savastano, & Colao, 2020). In fact, although not all countries have a Mediterranean diet tradition and dietary habits are influenced by cultural, environmental or economic factors, the MedDiet is still considered as one of the healthiest options worldwide (Chaudhry et al., 2020).

Previous results from individual countries have shown discrepancies among the adoption of healthy/unhealthy dietary habits during the COVID-19 confinement (Ammar et al., 2020; Di Renzo et al., 2020; Górnicka, Drywień, Zielinska, & Hamułka, 2020; Sidor & Rzymski, 2020; Xu et al., 2020). While there were differences among the studies in the methods applied to analyse this issue, those changes could potentially be driven by the cultural, environmental and economic factors within the country. Further than the aforementioned changes, the situation of confinement could have implied emotional dysregulation characterized by stress, fear and/or anxiety which have been proposed as a determinant factors of food choice (Poelman et al., 2020; López-Moreno et al., 2020). However, we hypothesize that the governmental policy responses against COVID-19 pandemic could also have influenced population eating behaviours.

During this situation of uncertainty about the effect of COVID-19 treatments throughout which many countries are experiencing new outbreaks that can lead to a new confinement, a deeper understanding of eating behaviour of the population is crucial to help in public health decision making related to nutritional recommendations that could positively impact on the prevention of COVID-19 infection and amelioration of COVID-19-related complications. Thus, the aim of this study is to provide a comprehensive picture of the changes in the eating behaviours during COVID-19 confinement, and assess the adherence to the MedDiet across 16 European countries with respect to the restriction measures imposed by the government as a response against current pandemic.

2. Material and methods

2.1. Study design

COVIDiet_Int is a large, multi-centre, cross-sectional study of >35 thousand adults from 16 European countries, including Bosnia and Herzegovina, Croatia, Denmark, Germany, Greece, Ireland, Italy, Lithuania, Montenegro, North Macedonia, Poland, Portugal, Serbia, Slovenia, Spain and Turkey, aiming to assess the dietary behavior of the population during COVID-19 confinement. A detailed description of the procedure and data collection has been reported elsewhere (Rodríguez-Pérez et al., 2020). The study was conducted in agreement with the Declaration of Helsinki, and all data were collected anonymously and recorded according to the Spanish Organic Law of Personal Data Protection (LOPD) 15/1999 and the European General Data Protection Regulation (GDPR) (EU) 2016/679. Participants were informed about the objective of the research and all provided online survey informed consent. This study was approved by the Research Ethics Committee of the University of Granada (1526/CEIH/2020) and it is registered with ClinicalTrials.gov number NCT 04449731.

2.2. Survey data collection

The survey was translated into the countrýs official languages and were launched during the first wave of COVID-19 pandemic. The questionnaire was distributed at similar time since the state of emergency was declared in each country and within two weeks/a month of the declaration of a state of emergency and the 'lockdown' measures.

More precisely, the survey was launched between the second and third week of confinement in Spain, Italy, Greece and Germany (March 2020), and from the first month of confinement in all other countries (April 2020). Multi-sourced tools including websites of research/academia in the field, social networking and social media were used to disseminate the online survey and non-probability sampling was used to recruit participants from the general population. The study recruitment was based on voluntary participation. The survey was available online for a mean duration of 22.4 days (±7.2 days) and data were collected between 20 March 2020 and 5 May 2020, though starting and ending dates varied between the countries.

2.3. Study participants

Male and female volunteers were invited to participate in the survey if they were at least 18 years of age at the time of the study and residing in one of the participating countries during the COVID-19 confinement. No other exclusion criteria were applied. The final sample consisted of 36,185 participants.

2.4. Assessment of dietary intake, dietary behaviour and lifestyle factors from survey data:

Overall, the online survey consisted of 44 diet and lifestyle related questions, and was structured into three main sections: i) general socio-demographic variables (gender, country, place of residence, educational level) and weight gain since the confinement; ii) food intake as defined by the 14-point Mediterranean Diet Adherence Screener (MEDAS) (Martínez-González et al., 2012), and additional information regarding the change in the consumption of these food items compared to the usual intake; iii) other variables related to dietary behaviours and lifestyle factors, such as applied cooking methods, intake of fast food, frequency of snacking, alcohol intake, physical activity, variation in the quantity of food eaten and the deviation from the usual behaviour resulted from confinement. Certain variables required further processing to ensure homogenisation of the data across countries. Thus, educational levels were collapsed into three main categories: basic education, medium level education and higher education, defined as having<10 years, 11–14 years and>15 years of education, respectively. Moreover, countries were grouped according to their geographical location into 3 main groups: Southern Mediterranean region (Greece, Italy, Portugal, Spain and Turkey), Balkan Mediterranean region (Bosnia, Croatia, North Macedonia, Montenegro and Slovenia) and non-Mediterranean region (Denmark, Germany, Ireland, Lithuania, Poland and Serbia).

3. Assessment of adherence to Mediterranean diet (MedDiet)

Dietary intake and adherence to the MedDiet during confinement was measured using the MEDAS score (Martínez-González et al., 2012). In brief, this questionnaire consisted of questions on intake frequency of MedDiet-related foods. Each question was scored 0–1. One point was given to the participants if they: 1) used olive oil as a main source, 2) preferred white over read meat, consumed predefined servings of "positive components": 3) > 4 of olive oil/d, 4) > 2 of vegetables/d, 5) > 3 of fruits/d, 6) > 7 of wine/wk, 7) > 3 of nuts/wk, 8) > 3 of legumes/wk, 9) > 3 of fish/wk, 10) > 2 of sauteed vegetable sauce (sofrito)/wk; and decreased amounts (as servings) of "negative components": 11) < 1 of red meat/d, 12) < 1 of fats/d, 13) < 1 of soft beverages/d and 14) < 2 of commercial pastry/wk. Zero points were given if these conditions were not met. The final MEDAS score ranges from 0 (minimum level of adherence) to 14 (maximum level of adherence).

The adherence to the MedDiet/MEDAS before confinement was estimated using the data on the changes in dietary intake during the confinement compared to the participants' usual intake. As described elsewhere (Rodríguez-Pérez et al., 2020), one points on the scale of MEDAS pre-confinement score was given to those participants who reported lower or the same intake of negative items such as red meat, fat, soft beverages and commercial pastry before lockdown. If the consumption of negative items before the confinement was higher, than 0 points were awarded. With respect to positive components of MEDAS score, one points on the scale of MEDAS pre-confinement score was given to those participants who reported increased or the same intake of positive items before lockdown. If the consumption of positive items before the confinement was lower, than 0 points were awarded (García-Conesa et al., 2020; Schröder et al., 2011).

Each score of adherence to MedDiet (before and during the confinement), was further grouped into 3 categories: low (≤5 points), medium (6 to 8 points) or high adherence (≥9 points) to the MedDiet. In addition, the change in MedDiet adherence from pre to post-confinement (change, no change) and the difference in adherence to the score was calculated.

3.1. Stringency index (SI)

The COVID-19 Government Response SI was extracted from the Oxford COVID-19 Government Response Tracker (OxCGRT), which is calculated based on 18 indicators and organised into three main sections: 1) containment and closure such as school, workplace or public transport closures, public event cancellations, or stay at home requirement, among others; 2) economic response such as income support, or giving international support, among others and 3) health system including emergency investment in healthcare, contact tracing, public information campaign or investment in COVID-19 vaccines, among others (Hale, Petherick, Phillips, & Webster, 2020). The SI represents the level of severity of the restriction measures imposed within every country and ranges from 0 (no restrictions) to 100 (maximum restrictions). The following categories of SI were considered: medium–high SI (60–80), high SI (81–90), very high SI (91–100) and non-defined SI (i.e., without any specification). The SI value was assigned on the questionnaire release date. This value remained unchanged during the survey period (data not shown).

3.2. Statistical analysis

Descriptive statistics were used to show and summarize the data, as means and standard deviations (SD) for continuous variables and frequencies and percentages for categorical variables. Differences between groups, i.e., countries, adherence to the MedDiet and categories of SI, in relation to all variables were evaluated through Student's *t*-test and one-way ANOVA (for continuous variables, and assuming normal distributions and variance homogeneity, as indicated by the Shapiro-Wilk's and Levene's tests, respectively), or Kruskal-Wallis test where appropriate, and Chi-squared test (for categorical variables), or alternatively Fisher's Exact test, where expected frequencies were observed to be less than five. The relationship between adherence to the MedDiet and the SI was explored in subgroup analyses. Furthermore, the relationship between pre/post difference in adherence to the MedDiet and SI was explored through Spearman correlation analysis. Two-tailed tests were used to determine significance at the 5% level and p-values were corrected for multiple comparisons by the Benjamini-Hochberg method. The data were analysed with R statistical software (version 4.0.1) (R Development Core Team 4.0.1., 2013).

4. Results

4.1. Baseline characteristics of the study sample

The total number of respondents was 36,185 (Table 1). The majority were females [overall: 77.6%; range: 65.7% (Italy) to 87.8% (Lithuania)], 21–35 years of age [overall: 42.7%; range: 34.0% (Spain) to 61.1% (Poland)], with higher educational level [overall: 75.2%; range: 62.7 (Italy) to 88.5% (Denmark)], living in family home [overall:

Table 1
Demographic and baseline descriptive characteristics of the study sample by countries.

	All countries	Southern Mediterranean region					Balkan Mediterranean region					Non-Mediterranean region					
		Greece	Italy	Portugal	Spain	Turkey	Bosnia	Croatia	N. Macedonia	Slovenia	Montenegro	Denmark	Germany	Ireland	Lithuania	Poland	Serbia
	n = 36185	n = 1488	n = 1411	n = 1308	n = 7514	n = 2733	n = 1507	n = 4281	n = 1057	n = 2648	n = 1655	n = 2462	n = 827	n = 714	n = 2447	n = 1927	n = 2206
Gender																	
Men	8058 (22.3%)	323 (21.7%)	481 (34.1%)	206 (15.7%)	2204 (29.3%)	611 (22.4%)	349 (23.2%)	829 (19.4%)	203 (19.2%)	497 (18.8%)	322 (19.5%)	708 (28.8%)	124 (15.0%)	178 (24.9%)	298 (12.2%)	299 (15.5%)	426 (19.3%)
Women	28,064 (77.6%)	1163 (78.2%)	927 (65.7%)	1099 (84.0%)	5305 (70.6%)	2116 (77.4%)	1156 (76.7%)	3444 (80.4%)	852 (80.6%)	2145 (81.0%)	1330 (80.4%)	1750 (71.1%)	699 (84.5%)	533 (74.6%)	2148 (87.8%)	1623 (84.2%)	1774 (80.4%)
Place of residence																	
Family home	27,133 (75.0%)	440 (29.6%)	1061 (75.2%)	434 (33.2%)	6150 (81.8%)	2490 (91.1%)	1355 (89.9%)	3532 (82.5%)	924 (87.4%)	1745 (65.9%)	717 (43.3%)	1936 (78.6%)	530 (64.1%)	555 (77.7%)	2050 (83.8%)	1417 (73.5%)	1797 (81.5%)
Shared flat	4903 (13.5%)	879 (59.1%)	160 (11.3%)	667 (51.0%)	535 (7.12%)	49 (1.79%)	28 (1.86%)	253 (5.91%)	69 (6.53%)	667 (25.2%)	757 (45.7%)	157 (6.38%)	116 (14.0%)	108 (15.1%)	125 (5.11%)	184 (9.55%)	149 (6.75%)
Student residence	252 (0.70%)	1 (0.07%)	7 (0.50%)	0 (0.00%)	31 (0.41%)	32 (1.17%)	6 (0.40%)	29 (0.68%)	7 (0.66%)	14 (0.53%)	3 (0.18%)	85 (3.45%)	0 (0.00%)	6 (0.84%)	9 (0.37%)	15 (0.78%)	7 (0.32%)
Living alone	3785 (10.5%)	168 (11.3%)	183 (13.0%)	207 (15.8%)	798 (10.6%)	162 (5.93%)	118 (7.83%)	467 (10.9%)	57 (5.39%)	222 (8.38%)	178 (10.8%)	284 (11.5%)	146 (17.7%)	45 (6.30%)	263 (10.7%)	234 (12.1%)	253 (11.5%)
Children in care [b]																	
No	20,868 (57.7%	1029 (69.2%)	954 (67.6%)	733 (56.0%)	4503 (59.9%)	1815 (66.4%)	660 (43.8%)	2552 (59.6%)	618 (58.5%)	1632 (61.6%)	674 (40.7%)	1203 (48.9%)	586 (70.9%)	527 (73.8%)	935 (38.2%)	1237 (64.2%)	1210 (54.9%)
Yes	15,317 (42.3%)	459 (30.8%)	457 (32.4%)	575 (44.0%)	3011 (40.1%)	918 (33.6%)	847 (56.2%)	1729 (40.4%)	439 (41.5%)	1016 (38.4%)	981 (59.3%)	1259 (51.1%)	241 (29.1%)	187 (26.2%)	1512 (61.8%)	690 (35.8%)	996 (45.1%)
Education level [a,b]																	
Basic	2044 (5.65%)	122 (8.20%)	104 (7.37%)	254 (19.4%)	768 (10.2%)	143 (5.23%)	13 (0.86%)	14 (0.33%)	8 (0.76%)	40 (1.51%)	20 (1.21%)	16 (0.65%)	21 (2.54%)	142 (19.9%)	329 (13.4%)	42 (2.18%)	8 (0.36%)
Medium	6935 (19.2%	128 (8.60%)	423 (30.0%)	64 (4.89%)	890 (11.8%)	494 (18.1%)	343 (22.8%)	1087 (25.4%)	350 (33.1%)	764 (28.9%)	508 (30.7%)	266 (10.8%)	206 (24.9%)	70 (9.80%)	164 (6.70%)	478 (24.8%)	700 (31.7%)
Higher	27,206 (75.2%)	1238 (83.2%)	884 (62.7%)	990 (75.7%)	5856 (77.9%)	2096 (76.7%)	1151 (76.4%)	3180 (74.3%)	699 (66.1%)	1844 (69.6%)	1127 (68.1%)	2180 (88.5%)	600 (72.6%)	502 (70.3%)	1954 (79.9%)	1407 (73.0%)	1498 (67.9%)
Age group, years [a,b]																	
<20	1425 (3.94%)	44 (2.96%)	24 (1.70%)	33 (2.52%)	229 (3.05%)	340 (12.4%)	31 (2.06%)	186 (4.34%)	91 (8.61%)	149 (5.63%)	69 (4.17%)	6 (0.24%)	8 (0.97%)	55 (7.70%)	45 (1.84%)	66 (3.43%)	49 (2.22%)
21–35	15,440 (42.7%)	785 (52.8%)	568 (40.3%)	525 (40.1%)	2558 (34.0%)	1488 (54.4%)	572 (38.0%)	1892 (44.2%)	510 (48.2%)	1188 (44.9%)	640 (38.7%)	864 (35.1%)	413 (49.9%)	406 (56.9%)	937 (38.3%)	1177 (61.1%)	917 (41.6%)
36–50	12,306 (34.0%)	447 (30.0%)	423 (30.0%)	488 (37.3%)	2371 (31.6%)	648 (23.7%)	669 (44.4%)	1622 (37.9%)	333 (31.5%)	835 (31.5%)	767 (46.3%)	917 (37.2%)	257 (31.1%)	172 (24.1%)	898 (36.7%)	541 (28.1%)	918 (41.6%)
51–65	5956 (16.5%)	193 (13.0%)	297 (21.0%)	223 (17.0%)	1928 (25.7%)	230 (8.42%)	220 (14.6%)	541 (12.6%)	109 (10.3%)	402 (15.2%)	157 (9.49%)	578 (23.5%)	126 (15.2%)	69 (9.66%)	490 (20.0%)	131 (6.80%)	262 (11.9%)
>65	1058 (2.92%)	19 (1.28%)	99 (7.02%)	39 (2.98%)	428 (5.70%)	27 (0.99%)	15 (1.00%)	40 (0.93%)	14 (1.32%)	74 (2.79%)	22 (1.33%)	97 (3.94%)	23 (2.78%)	12 (1.68%)	77 (3.15%)	12 (0.62%)	60 (2.72%)

Data presented are n (%).
[a] significance across countries within the specified region (p-value: <0.001): educational level, age.
[b] significance across all countries (p-value: <0.001): children in care, educational level, age.

Table 2
Adherence to the Mediterranean Diet (MedDiet) before and during COVID-19 confinement by countries.

Food groups	All countries	Southern Mediterranean region					Balkan Mediterranean region					Non-Mediterranean region					
		Greece	Italy	Portugal	Spain	Turkey	Bosnia	Croatia	N. Macedonia	Slovenia	Montenegro	Denmark	Germany	Ireland	Lithuania	Poland	Serbia
	n = 36185	n = 1488	n = 1411	n = 1308	n = 7514	n = 2733	n = 1507	n = 4281	n = 1057	n = 2648	n = 1655	n = 2462	n = 827	n = 714	n = 2447	n = 1927	n = 2206
MedDiet confinement, mean (SD) [a b]	6.15 (2.06)	6.88 (1.77)	6.70 (1.62)	7.34 (1.95)	7.18 (1.84)	5.70 (1.89)	5.46 (2.09)	5.85 (2.04)	5.90 (2.09)	6.08 (1.80)	5.59 (2.13)	5.45 (2.09)	5.91 (1.90)	5.82 (2.18)	5.13 (1.88)	5.99 (2.01)	5.58 (1.98)
MedDiet confinement levels [a b]																	
Low	13,673 (37.8%)	309 (20.8%)	301 (21.3%)	207 (15.8%)	1320 (17.6%)	1286 (47.1%)	787 (52.2%)	1892 (44.2%)	468 (44.3%)	971 (36.7%)	844 (51.0%)	1250 (50.8%)	347 (42.0%)	327 (45.8%)	1466 (59.9%)	789 (40.9%)	1109 (50.3%)
Medium	17,914 (49.5%)	935 (62.8%)	926 (65.6%)	743 (56.8%)	4410 (58.7%)	1258 (46.0%)	606 (40.2%)	1956 (45.7%)	475 (44.9%)	1459 (55.1%)	659 (39.8%)	1043 (42.4%)	412 (49.8%)	304 (42.6%)	869 (35.5%)	929 (48.2%)	930 (42.2%)
High	4598 (12.7%)	244 (16.4%)	184 (13.0%)	358 (27.4%)	1784 (23.7%)	189 (6.92%)	114 (7.56%)	433 (10.1%)	114 (10.8%)	218 (8.23%)	152 (9.18%)	169 (6.86%)	68 (8.22%)	83 (11.6%)	112 (4.58%)	209 (10.8%)	167 (7.57%)
MedDiet before, mean (SD) [a b]	5.23 (2.06)	5.58 (1.75)	5.81 (1.65)	6.37 (2.00)	6.37 (1.94)	4.52 (1.83)	4.45 (1.97)	5.02 (1.97)	4.46 (1.99)	5.23 (1.84)	4.47 (2.00)	4.92 (2.05)	4.96 (1.78)	4.88 (2.01)	4.41 (1.86)	5.11 (2.05)	4.49 (1.94)
MedDiet before levels [a b]																	
Low	20,546 (56.8%)	741 (49.8%)	643 (45.6%)	435 (33.3%)	2588 (34.4%)	1950 (71.4%)	1074 (71.3%)	2657 (62.1%)	760 (71.9%)	1507 (56.9%)	1179 (71.2%)	1508 (61.3%)	509 (61.5%)	465 (65.1%)	1816 (74.2%)	1123 (58.3%)	1591 (72.1%)
Medium	13,381 (37.0%)	678 (45.6%)	689 (48.8%)	687 (52.5%)	3875 (51.6%)	728 (26.6%)	388 (25.7%)	1418 (33.1%)	263 (24.9%)	1036 (39.1%)	426 (25.7%)	851 (34.6%)	300 (36.3%)	211 (29.6%)	583 (23.8%)	692 (35.9%)	556 (25.2%)
High	2258 (6.24%)	69 (4.64%)	79 (5.60%)	186 (14.2%)	1051 (14.0%)	55 (2.01%)	45 (2.99%)	206 (4.81%)	34 (3.22%)	105 (3.97%)	50 (3.02%)	103 (4.18%)	18 (2.18%)	38 (5.32%)	48 (1.96%)	112 (5.81%)	59 (2.67%)
Change in MedDiet [a b]																	
Yes	18,468 (51.0%)	971 (65.3%)	754 (53.4%)	682 (52.1%)	3392 (45.1%)	1795 (65.7%)	796 (52.8%)	2024 (47.3%)	702 (66.4%)	1296 (48.9%)	948 (57.3%)	868 (35.3%)	544 (65.8%)	375 (52.5%)	1061 (43.4%)	961 (49.9%)	1300 (58.9%)
No	17,715 (49.0%)	517 (34.7%)	657 (46.6%)	626 (47.9%)	4122 (54.9%)	938 (34.3%)	711 (47.2%)	2257 (52.7%)	355 (33.6%)	1352 (51.1%)	707 (42.7%)	1594 (64.7%)	283 (34.2%)	339 (47.5%)	1386 (56.6%)	966 (50.1%)	906 (41.1%)
Difference in MedDiet, mean (SD) [a b]	0.91 (1.15)	1.29 (1.29)	0.90 (1.08)	0.97 (1.23)	0.81 (1.12)	1.18 (1.13)	1.00 (1.24)	0.84 (1.12)	1.45 (1.42)	0.86 (1.02)	1.12 (1.28)	0.53 (0.86)	0.95 (0.93)	0.95 (1.15)	0.71 (1.01)	0.88 (1.12)	1.10 (1.20)

Data are n (%) unless otherwise indicated; SD in the case of MedDiet scale or difference.
The adherence to the MedDiet/MEDAS before confinement was estimated using the data on the changes in dietary intake during the confinement compared to the participants' usual intake.
[a] significance across countries within the specified region (p-value: <0.001).
[b] significance across all countries (p-value: <0.001).

75%; range: 29.6% (Greece) to 91.1% (Turkey)] and did not have children in care [overall: 57.7%; range: 38.2% (Lithuania) to 73.8% (Ireland)].

4.2. Adherence to the MedDiet

A significantly higher adherence to the MedDiet during the confinement was observed across all countries (overall MEDAS score prior to- and during confinement: 5.23 ± 2.06 (min–max: 1–13) vs. 6.15 ± 2.06 (min–max: 1–14); $p < 0.001$). Adherence to the MedDiet (Table 2, Fig. 1) was observed to be the highest in Southern Mediterranean region (MEDAS score > 5.58, except for Turkey), with Portugal and Spain reaching the highest score both before and during confinement (Portugal: 6.37 and 7.34; Spain: 6.37 and 7.18, respectively). Adherence to the MedDiet before the confinement was significantly lower in other countries (MEDAS score < 5.11 for non-Mediterranean countries and < 5.23 for Balkan Mediterranean countries), but tended to increase during confinement to a varying extent. For instance, MedDiet adherence significantly increased ($p < 0.001$) across all countries from pre to post-confinement: by > 1 point in Greece, Turkey, North Macedonia and Serbia, and by > 0.8 points in the remaining countries, except for Denmark and Lithuania, where the increase was notably lower (0.53 and 0.71, respectively). At the region-level, this change was more noticeable in the Southern and Balkan Mediterranean countries, in which the average MedDiet score increased by 1.04 and 1.05 points, respectively, compared to the non-Mediterranean countries where the increment of the average MEDAS score was 0.85 during the confinement.

Dietary intakes during COVID-19 confinement by categories of adherence to MedDiet, before and during confinement are presented in Table 3. There were 6,873 participants (19%) who shifted from low MedDiet adherence before confinement (N low = 20,546) to medium or high MedDiet adherence during confinement (N low = 13,673). This shift was achieved through the increase in the consumption of all MedDiet-related food items. Among participants within the low adherence groups, for example, meaningful differences were observed between pre- and post-confinement: 4–5% of the participants in the lowest adherence group increased the consumption of olive oil and legumes, or decreased that of soft beverages and pastries, whereas 8–9% increased the consumption of fruits and vegetables, or decreased that of red meat. Indeed, approximately 10–15% of the participants reported that their intake of olive oil, legumes and fish increased during the confinement, and around 20–25% reported an increase of fruits and vegetables, whereas their intake of red meat, soft beverages and pastries decreased overall (Table S1). Slight differences in those trends were seen by countries and regions, although it was far less pronounced for Denmark (e.g., only 11% of Danish participants increased the intake of fruits and vegetables), as a result of the smaller variation of the MedDiet adherence in this country. The same trends, pointing to higher intakes of MedDiet-related foods in medium and high adherence groups, were observed by comparing those variations in the dietary intake of MEDAS components during confinement (Table S2). Regarding other dietary behaviour and lifestyle factors (Table S3), similar patterns across the countries were also observed. In particular, the majority of participants (>90%) reported to have maintained or decreased the consumption of fast food and fried food, and to cook more often during the confinement. A small proportion (<10%) reported frying as the most common cooking method, although not on a daily basis (<1% reported > 7 times/wk), and to use preferably olive oil together with sunflower oil for frying. Besides, almost half of the participants (45.1%) increased overall intake during the confinement, as was also noted by the reported higher consumption of snacks (36%) and homemade pastry (40%). Again, these trends were less noticeable for Denmark. Regarding lifestyle factors, approximately half (48.7%) of the participants became less physically active, approximately a fifth (29.0%) reported an increase in physical activity level, another fifth (20.9%) reported the same exercise level as before, and fewer kept being physically inactive (8.5%). Thus, physical activity was reduced by>45% in Southern and Non-Mediterranean region (except for Ireland), and in North Macedonia and Montenegro in the Balkan region. While 26.8% of participants were not aware of any weight variation during the confinement, the majority (50.7%) did not experience any weight gain. Concerning MedDiet adherence before and during confinement (Table S4), there were also some substantial changes seen due to the confinement among participants with medium/high MedDiet adherence, most notably a decrease in the consumption of fast food (>40%), fried food (>24%) and snacks (>18%).

4.3. Stringency index and MedDiet

On average, 37% of the participants were from countries with a medium–high SI, whereas 33.3% and 21.8% were from countries with high or very high SI, respectively (Fig. 2). Nearly half of the participants

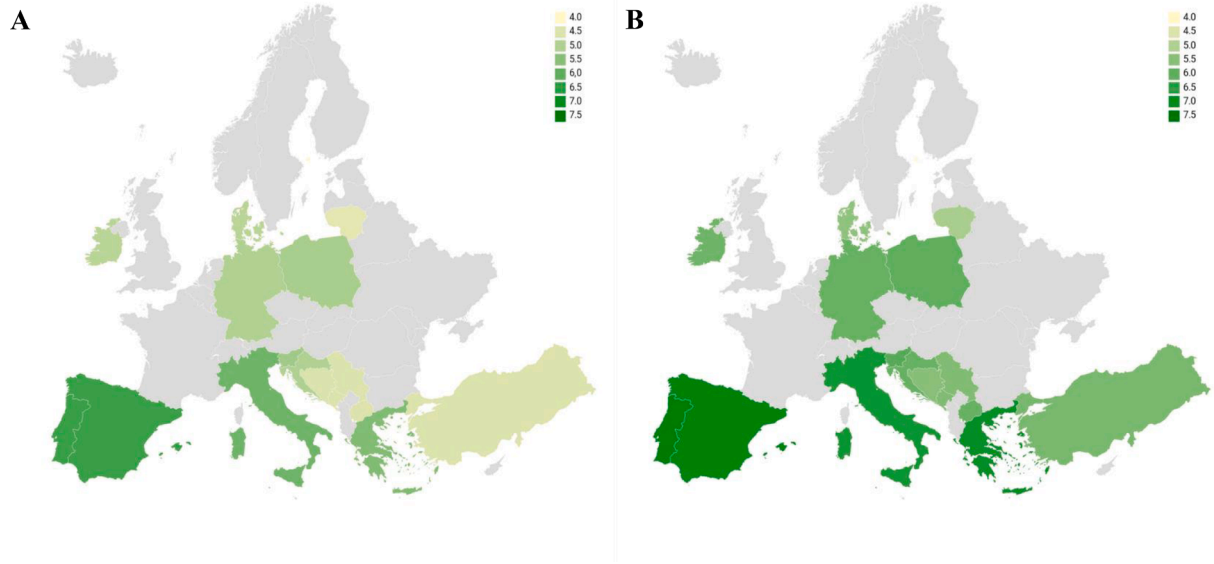

Fig. 1. MEDAS Score of adherence to the MedDiet before and during COVID-19 confinement across countries. MEDAS Score of adherence to the MedDiet before (A) and during (B) COVID-19 confinement across countries. MEDAS = Mediterranean Diet Adherence Screener. MEDAS ranges from 0 to 14.

Table 3
Dietary intake of MEDAS defined items during COVID-19 confinement by categories of adherence to MedDiet, before and during confinement.

	MedDiet before COVID-19 confinement			MedDiet during COVID-19 confinement		
	Low n = 20546	Medium n = 13381	High n = 2258	Low n = 13673	Medium n = 17914	High n = 4598
Olive oil main source [a]						
No	10,869 (52.9%)	2352 (17.6%)	115 (5.09%)	8852 (64.7%)	4165 (23.2%)	319 (6.94%)
Yes	9677 (47.1%)	11,029 (82.4%)	2143 (94.9%)	4821 (35.3%)	13,749 (76.8%)	4279 (93.1%)
Olive oil (tablespoons/d) [a]						
>4	2213 (10.8%)	3379 (25.3%)	1089 (48.2%)	825 (6.03%)	3792 (21.2%)	2064 (44.9%)
2.0–3.9	6917 (33.7%)	5736 (42.9%)	755 (33.4%)	4062 (29.7%)	7695 (43.0%)	1651 (35.9%)
0 – 1.9	11,416 (55.6%)	4266 (31.9%)	414 (18.3%)	8786 (64.3%)	6427 (35.9%)	883 (19.2%)
Vegetables (servings/d) [a]						
>2	4380 (21.3%)	5709 (42.7%)	1699 (75.2%)	1895 (13.9%)	6484 (36.2%)	3409 (74.1%)
1.0–1.9	11,684 (56.9%)	6202 (46.3%)	499 (22.1%)	8184 (59.9%)	9135 (51.0%)	1066 (23.2%)
0 – 0.9	4482 (21.8%)	1470 (11.0%)	60 (2.66%)	3594 (26.3%)	2295 (12.8%)	123 (2.68%)
Fruits (servings/d) [a]						
>3	2984 (14.5%)	3250 (24.3%)	1253 (55.5%)	1125 (8.23%)	3877 (21.6%)	2485 (54.0%)
1.0–2.9	11,631 (56.6%)	7556 (56.5%)	849 (37.6%)	7972 (58.3%)	10,293 (57.5%)	1771 (38.5%)
0 – 0.9	5931 (28.9%)	2575 (19.2%)	156 (6.91%)	4576 (33.5%)	3744 (20.9%)	342 (7.44%)
Red meat (servings/d) [a]						
>1.0	7780 (37.9%)	1814 (13.6%)	104 (4.61%)	6639 (48.6%)	2797 (15.6%)	262 (5.70%)
0 – 0.9	12,766 (62.1%)	11,567 (86.4%)	2154 (95.4%)	7034 (51.4%)	15,117 (84.4%)	4336 (94.3%)
Fats (servings/d) [a]						
>1	6102 (29.7%)	1337 (9.99%)	71 (3.14%)	4953 (36.2%)	2354 (13.1%)	203 (4.41%)
0–0.9	14,444 (70.3%)	12,044 (90.0%)	2187 (96.9%)	8720 (63.8%)	15,560 (86.9%)	4395 (95.6%)
Soft beverages (servings/d) [a]						
>1.0	3265 (15.9%)	577 (4.31%)	32 (1.42%)	2835 (20.7%)	953 (5.32%)	86 (1.87%)
0 – 0.9	17,281 (84.1%)	12,804 (95.7%)	2226 (98.6%)	10,838 (79.3%)	16,961 (94.7%)	4512 (98.1%)
Wine (cups/wk) [a]						
>7	425 (2.07%)	662 (4.95%)	228 (10.1%)	258 (1.89%)	673 (3.76%)	384 (8.35%)
3–6.9	1773 (8.63%)	1387 (10.4%)	244 (10.8%)	1164 (8.51%)	1778 (9.93%)	462 (10.0%)
0–2.9	8073 (39.3%)	5483 (41.0%)	844 (37.4%)	5306 (38.8%)	7335 (40.9%)	1759 (38.3%)
Never	10,275 (50.0%)	5849 (43.7%)	942 (41.7%)	6945 (50.8%)	8128 (45.4%)	1993 (43.3%)
Legumes (servings/wk) [a]						
>3	1717 (8.36%)	2649 (19.8%)	1090 (48.3%)	586 (4.29%)	2735 (15.3%)	2135 (46.4%)
1.0–2.9	10,496 (51.1%)	7317 (54.7%)	927 (41.1%)	6757 (49.4%)	10,052 (56.1%)	1931 (42.0%)
0 – 0.9	8333 (40.6%)	3415 (25.5%)	241 (10.7%)	6330 (46.3%)	5127 (28.6%)	532 (11.6%)
Fish (servings/wk) [a]						
>3	821 (4.00%)	1600 (12.0%)	803 (35.6%)	232 (1.70%)	1518 (8.47%)	1474 (32.1%)
1.0–2.9	8165 (39.7%)	6490 (48.5%)	911 (40.3%)	5113 (37.4%)	8474 (47.3%)	1979 (43.0%)
0 – 0.9	11,560 (56.3%)	5291 (39.5%)	544 (24.1%)	8328 (60.9%)	7922 (44.2%)	1145 (24.9%)
Preference for white meat [a]						
No	8233 (40.1%)	2586 (19.3%)	241 (10.7%)	6559 (48.0%)	3980 (22.2%)	521 (11.3%)
Yes	12,313 (59.9%)	10,795 (80.7%)	2017 (89.3%)	7114 (52.0%)	13,934 (77.8%)	4077 (88.7%)
Pastry (servings/wk) [a]						
>2.0	8100 (39.4%)	2828 (21.1%)	185 (8.19%)	6614 (48.4%)	4074 (22.7%)	425 (9.24%)
0 – 1.9	12,446 (60.6%)	10,553 (78.9%)	2073 (91.8%)	7059 (51.6%)	13,840 (77.3%)	4173 (90.8%)
Nuts (servings/wk) [a]						
>3	2748 (13.4%)	4784 (35.8%)	1578 (69.9%)	1195 (8.74%)	4923 (27.5%)	2992 (65.1%)
1.0–2.9	7413 (36.1%)	4061 (30.3%)	389 (17.2%)	4897 (35.8%)	6065 (33.9%)	901 (19.6%)
0 – 0.9	10,385 (50.5%)	4536 (33.9%)	291 (12.9%)	7581 (55.4%)	6926 (38.7%)	705 (15.3%)
Sofrito[1] **(servings/wk)** [a]						
>2	7298 (35.5%)	7920 (59.2%)	1718 (76.1%)	3773 (27.6%)	9655 (53.9%)	3508 (76.3%)
1.0–1.9	8083 (39.3%)	3598 (26.9%)	350 (15.5%)	5835 (42.7%)	5457 (30.5%)	739 (16.1%)
0 – 0.9	5165 (25.1%)	1863 (13.9%)	190 (8.41%)	4065 (29.7%)	2802 (15.6%)	351 (7.63%)

The adherence to the MedDiet/MEDAS before confinement was estimated using the data on the changes in dietary intake during the confinement compared to the participants' usual intake.

[1] Defined as cooked vegetable, pasta, rice or other dishes seasoned with tomato, garlic, onion or leak sauce made over low heat with olive oil

[a] Significant difference across categories (p-value: <0.001).

from the Balkan Mediterranean region (54.2%) were subjected to the highest SI (very high SI), while the majority (75.7%) of the participants from the Southern Mediterranean region lived under the lowest SI (medium–high SI) during the confinement. Denmark presented the lowest SI of all countries. No change in the SI during the confinement was observed in any of the participating countries, except for Spain and Bosnia (increase in SI), and for Lithuania (decrease in SI) in the last week of the study (data not shown).

Dietary intakes of foods included in the MedDiet score according to categories of the SI are shown in Table 4 and Fig. 3. Eating behaviour and lifestyle adaptation during the COVID-19 confinement subject to the same categories showed that (Fig. 4, Tables S5 and S6), overall, a consistent tendency towards higher intakes of traditional MedDiet foods, and lower intakes of suboptimal food items (e.g., red meat and soft beverages) in all regions and regardless of the SI level. Participants from countries with high and very high SI reported significantly increased intakes of vegetables, fruits or fish when compared to those with lower SI (higher intakes: 21.5 and 22.4% in high/very high SI vs 17.9% in low SI; 25.3 and 24.8% in high/very high SI vs 19.3% in low SI, and 10.2 and 11.4% in high/very high SI vs 8.42% in low SI, respectively). Lower intakes of soft beverages (>90% of the participants consumed less than one serving/d), higher intakes of sofrito (>50% of the participants consumed more than two servings/wk), and higher rate of preference for white meat (>70% of the participants) were observed in high and very high SI regions; participants from those regions presented a higher MEDAS score for above mentioned items. On the other

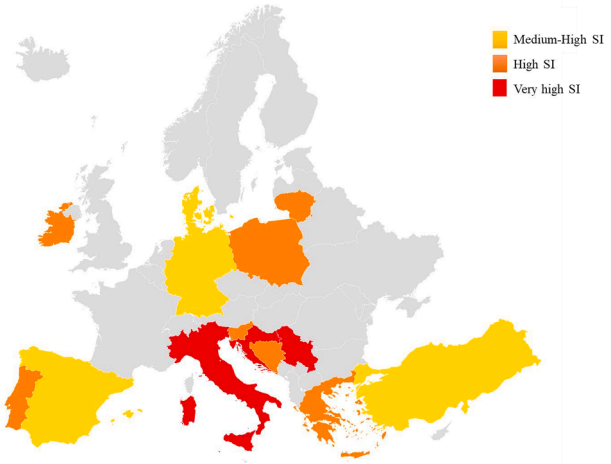

Fig. 2. SI levels representing the severity of restrictions imposed by the government across countries. SI index for the participating countries: Bosnia and Herzegovina: 85.19; Croatia: 96.3; Denmark: 68.52; Germany: 73.15; Greece: 84.26; Ireland: 85.19; Italy: 91.67; Lithuania: 81.84; Montenegro: Not available; North Macedonia: Not available; Poland: 83.33; Portugal: 82.81; Serbia: 100; Slovenia: 89.81; Spain: 71.76 and Turkey: 78.7. Data from the OxCGRT. Available at https://covidtracker.bsg.ox.ac.uk/SI=stringency index.

hand, medium–high SI regions included higher proportion of olive oil consumers as well as participants with high intakes of nuts, vegetables, fish and legumes. For other food groups, discrete differences were found by the SI categories.

A significant proportion of participants changed from low to medium or high levels of adherence to the MedDiet during the confinement ($p < 0.001$) (Table 5). The prevalence of low MedDiet adherence before and during confinement was greater in very high/high SI categories (from to 60 to 40%, respectively) compared to medium–high SI category (from 49% to 31%). Mean adherence to the MedDiet before and during confinement was also significantly higher in countries that imposed medium–high SI restriction measures compared to countries of other stringency categories ($p < 0.001$). Despite the fact that all countries significantly increased the adherence to the MedDiet during the confinement, a significantly higher increase in the MEDAS score among the countries of a higher SI compared to those with a medium–high SI (0.92 vs 0.84 points increase, respectively) ($p < 0.001$) was observed. Among medium–high SI countries, Denmark was the one presenting the lowest SI and MEDAS score. No significant differences were found between the countries with the highest SI (data not shown). In addition, there was a significant positive correlation (rho = 0.53, $p < 0.001$) between the SI for each country and the change in MedDiet adherence from pre to post-confinement (data not shown). A significantly higher proportion of participants from very high and high SI categories seemed to adopt healthier dietary practices (Table S6), including lower consumption of fast food, fried food, snacks, and pastries, along with an increased frequency of cooking ($p < 0.001$). In line with these results, the prevalence of those who reported lower physical activity or no weight gain during confinement was also significantly smaller among the very high and high SI categories.

5. Discussion

Findings from this study indicate that adults from 16 different European countries have unexpectedly adopted a healthier dietary pattern during the COVID-19 outbreak confinement as reflected by a significant increase in the adherence to the MedDiet. The most prominent adherence to the MedDiet was observed within the Mediterranean region. Thus, Portugal, Spain, Greece and Italy have reported an increase in MEDAS score, with Portugal and Spain reporting the highest MEDAS score during confinement. Similar MedDiet adherence (MEDAS score of 7) was observed among Italian population by Di Renzo and colleagues during the COVID-19 confinement (Di Renzo et al., 2020). However, as no estimation of the change in the MedDiet adherence pre- and post-COVID-19 was performed by the authors, it made it difficult compare the results of this study with our findings. The improvement in the adherence to MedDiet is a promising step forward, as it stands out even the traditional Mediterranean countries experience the shift towards more Westernized dietary pattern (Peñalvo et al., 2016).

It is important to highlight that in countries with the highest level of restriction measures imposed by the government to contain the spread of the COVID-19, people adopted healthier dietary behaviours, and improved adherence to the MedDiet, which in the long term might have a potential beneficial effect on their overall health. In those countries the increase in the intake of MedDiet-related foods such as vegetables, fruits or fish during the confinement was more noticeable. Precisely, those foods contain important nutrients which are crucial for the immune system maintenance, for instance, antioxidants such as vitamins C, E and beta-carotene from fruits, vegetables and olive oil or vitamin D and omega-3 fatty acids from fish. Antioxidants such as vitamin E have already shown promising results against viral titer influenza virus infection (Han et al., 2000; Uchide & Toyoda, 2011) while vitamin D has also been proposed as complementary therapy for reducing the risk of influenza infection (Grant et al., 2020) and as preventive measure against common upper respiratory tract infections (Autier et al., 2017). Over the last months, this vitamin has been investigated for its potential implication in amelioration of COVID-19 related complications (Martineau & Forouhi, 2020). Additionally, stricter conditions have resulted in the situation where the population had less access to take away foods and, as a consequence, has decreased the frequency of eating out, which is supported by our findings showing an increased frequency of cooking at home during the confinement. It should be mentioned that in many countries, even with high restrictions (e.g., Croatia, Italy and Serbia), food delivery services were allowed. Nevertheless, and despite we did not collect this information, a population concern about the risks of getting take-aways or delivery at that time of COVID-19 should not be discarded. Increase of cooking during this period has been also reported by other recently published research (Marty et al., 2020; Giacalone, Frøst, & Rodríguez-Pérez, 2020; Kriaucioniene, Bagdonaviciene, Rodríguez-Pérez, & Petkeviciene, 2020). During the confinement, people had more time for cooking to pass free time alone of with children, selecting foods they perceived as healthy such as fresh vegetables (Laguna et al., 2020) which support the increase of adherence to the MedDiet among the adult population included in the study. As previously shown, weekly consumption of take away is related with a poorer dietary quality, overall unhealthier dietary pattern and non-compliance with dietary recommendations, and increased prevalence of chronic conditions (Smith et al., 2009). On the other hand, cooking at home has previously shown to be related with higher dietary quality, which explains the reason behind higher MEDAS score among those countries with stricter conditions in our study (Wolfson & Bleich, 2015). The findings from other studies with high SI measures derived contradicting results. A cross-sectional study (n = 22,459) performed in China, a country with SI of 81, reported that participants with higher epidemic concerns were more willing to adopt healthy dietary habits, especially women, those with the higher educational level and the elderly (Xu et al., 2020). Contrarily, Sidor & Rzymski found that in Poland (n = 1,097), a country with SI of 83.3, a reduced daily consumption of fresh vegetables and fruits was observed during the COVID-19 confinement even when 62.3% of surveyed reported to had increased cooking during that period (Sidor & Rzymski, 2020).

However, despite the higher change to the MedDiet adherence in the countries with higher SI, the highest MEDAS score before and during the confinement was found among the countries with medium–high SI. These findings were expected as the majority of participants within that

Table 4
Dietary intake of MEDAS defined items during COVID-19 confinement by categories of the stringency index.

	Very high SI N = 7898	High SI N = 12039	Medium high SI N = 13536	Non-defined N = 2712
Olive oil main source [a]				
Yes	4042 (51.2%)	6764 (56.2%)	10,961 (81.0%)	1082 (39.9%)
No	3856 (48.8%)	5275 (43.8%)	2575 (19.0%)	1630 (60.1%)
Olive oil (tablespoons/d) [a]				
>4	1414 (17.9%)	1565 (13.0%)	3302 (24.4%)	400 (14.7%)
2.0–3.9	2828 (35.8%)	3898 (32.4%)	5860 (43.3%)	822 (30.3%)
0 – 1.9	3656 (46.3%)	6576 (54.6%)	4374 (32.3%)	1490 (54.9%)
Vegetables (servings/d) [a]				
>2	1919 (24.3%)	3602 (29.9%)	5537 (40.9%)	730 (26.9%)
1.0–1.9	4569 (57.9%)	6151 (51.1%)	6067 (44.8%)	1598 (58.9%)
0 – 0.9	1410 (17.9%)	2286 (19.0%)	1932 (14.3%)	384 (14.2%)
Fruits (servings/d) [a]				
>3	1402 (17.8%)	2697 (22.4%)	2517 (18.6%)	871 (32.1%)
1.0–2.9	4455 (56.4%)	6568 (54.6%)	7632 (56.4%)	1381 (50.9%)
0 – 0.9	2041 (25.8%)	2774 (23.0%)	3387 (25.0%)	460 (17.0%)
Meat (servings/d) [a]				
>1.0	2313 (29.3%)	3220 (26.7%)	3361 (24.8%)	804 (29.6%)
0 – 0.9	5585 (70.7%)	8819 (73.3%)	10,175 (75.2%)	1908 (70.4%)
Fats (servings/d) [a]				
>1	1407 (17.8%)	2905 (24.1%)	2359 (17.4%)	839 (30.9%)
0–0.9	6491 (82.2%)	9134 (75.9%)	11,177 (82.6%)	1873 (69.1%)
Soft beverages (servings/d) [a]				
>1.0	682 (8.64%)	1170 (9.72%)	1658 (12.2%)	364 (13.4%)
0 – 0.9	7216 (91.4%)	10,869 (90.3%)	11,878 (87.8%)	2348 (86.6%)
Wine (cups/wk) [a]				
>7	296 (3.75%)	379 (3.15%)	576 (4.26%)	64 (2.36%)
3–6.9	701 (8.88%)	1088 (9.04%)	1387 (10.2%)	228 (8.41%)
0–2.9	3434 (43.5%)	5218 (43.3%)	4640 (34.3%)	1108 (40.9%)
Never	3467 (43.9%)	5354 (44.5%)	6933 (51.2%)	1312 (48.4%)
Legumes (servings/wk) [a]				
>3	936 (11.9%)	1765 (14.7%)	2200 (16.3%)	555 (20.5%)
1.0–2.9	4333 (54.9%)	5266 (43.7%)	7663 (56.6%)	1478 (54.5%)
0 – 0.9	2629 (33.3%)	5008 (41.6%)	3673 (27.1%)	679 (25.0%)
Fish (servings/wk) [a]				
>3	480 (6.08%)	920 (7.64%)	1653 (12.2%)	171 (6.31%)
1.0–2.9	3537 (44.8%)	4631 (38.5%)	6167 (45.6%)	1231 (45.4%)
0 – 0.9	3881 (49.1%)	6488 (53.9%)	5716 (42.2%)	1310 (48.3%)
Preference for white meat [a]				
No	2228 (28.2%)	3368 (28.0%)	4475 (33.1%)	989 (36.5%)
Yes	5670 (71.8%)	8671 (72.0%)	9061 (66.9%)	1723 (63.5%)
Pastry (servings/wk) [a]				
>2.0	2930 (37.1%)	3694 (30.7%)	3570 (26.4%)	919 (33.9%)
0 – 1.9	4968 (62.9%)	8345 (69.3%)	9966 (73.6%)	1793 (66.1%)
Nuts (servings/wk) [a]				
>3	1861 (23.6%)	2395 (19.9%)	4165 (30.8%)	689 (25.4%)
1.0–2.9	2624 (33.2%)	3805 (31.6%)	4343 (32.1%)	1091 (40.2%)
0 – 0.9	3413 (43.2%)	5839 (48.5%)	5028 (37.1%)	932 (34.4%)
Sofrito[1] **(servings/wk)** [a]				
>2	4546 (57.6%)	6478 (53.8%)	4631 (34.2%)	1281 (47.2%)
1.0–1.9	2280 (28.9%)	3599 (29.9%)	5277 (39.0%)	875 (32.3%)
0 – 0.9	1072 (13.6%)	1962 (16.3%)	3628 (26.8%)	556 (20.5%)

Countries by SI categories: Croatia, Serbia and Italy (very high SI); Bosnia, Greece, Lithuania, Poland, Portugal and Slovenia (high SI); Denmark, Spain, Germany, Turkey (medium–high SI); North Macedonia and Montenegro (non-defined SI).

[1] Defined as cooked vegetable, pasta, rice or other dishes seasoned with tomato, garlic, onion or leak sauce made over low heat with olive oil.

[a] Significant difference across categories (p-value: <0.001)

category were from Southern Mediterranean countries with a long Mediterranean diet tradition. In addition, the majority of those participants were 51 years of age or older, who had previously shown a higher adherence to the MedDiet (León-Muñoz et al., 2012; Rodríguez-Pérez et al., 2020). Maintenance of the usual dietary habits was also seen in the PLifeCOVID-19 Study of 2,381 adults from Poland, reported that population above the age of 50 years were more prone to maintain their usual dietary intake during the COVID-19 confinement (Górnicka et al., 2020). The same was found by Snuggs and McGregor among English speaker participants (Snuggs & McGregor, 2020). Younger generation of PLifeCOVID-19 Study, on the other hand, were more likely to increase consumption of healthy foods (Górnicka et al., 2020), which is also supported by the findings from the Italian survey showing higher adherence to the MedDiet during the confinement among 18–30 years old, compared to the elderly population (Di Renzo et al., 2020).

It is essential to highlight that countries with high and very high SI have demonstrated higher reduction in the consumption of fast foods, soft beverages and frequency of snacking. The aforementioned Polish study, however, observed an opposite trend showing an increase in snacking frequency (Sidor & Rzymski, 2020). On the other hand, similar to our findings, a study from Italy (EHLC-COVID19), a country which would be considered "high SI", reported a reduction in the intake of savoury snacks (Di Renzo et al., 2020).

It should not be forgotten that the restrictions measures could

Fig. 3. Balloon plot showing MedDiet-related food items (MEDAS score) by SI categories. The balloon size, colour gradient and values represent the percentages of respondents meeting the criteria for scoring one points of the MEDAS defined food item.

potentially cause economic and health related stress and, anxiety among the European population (Sabat et al., 2020). The measures imposed have caused mental distress (Pierce et al., 2020), which has been addressed through the guidelines from health authorities. In fact, some authors have postulated that changes in food purchasing in response to the pandemic may be motivated by psychological factors (Laguna et al., 2020; Snuggs & McGregor, 2020). The emphasis was placed on the importance of healthier diet and lifestyle to tackle this issue, which in turn, could potentially explain higher adherence to a healthier dietary pattern among those countries with the high SI in our study. On the other hand, contradicting findings from other studies could have been linked to stress induced unhealthy habits among general population. As it has been reported previously, emotional distress increases the intake of hyperpalatable foods which may serve as "comfort food" to ease an unwanted distress (Rutters, Nieuwenhuizen, Lemmens, Born, & Westerterp-Plantenga, 2009).

Majority of participants in our study decreased their physical activity level during the confinement. Despite the imposed restrictions on movement, physical activity engagement was still high, which could potentially explain the reason participants did not experience weight gain. Also, as a matter of fact, the survey was administered at the beginning of confinement, thus, taking into account limited time of exposure to the restriction measures, the weight gain in our study was not expected. It is worth considering the role of physical activity in the prevention of COVID-19 related complications as its importance in alleviating complications from viral infections has already been proven (Jakobsson, Malm, Furberg, Ekelund, & Svensson, 2020). In addition to the effect of adopting a healthier diet, maintaining a physical activity level would improve common chronic conditions that considered as risk factors for higher COVID-19 mortality.

Strengths and limitations of the present work are worth mentioning. Briefly, our study is the first large European study to provide insight on the immediate effect of COVID-19 confinement on dietary intake, eating behaviours and adherence to the MedDiet, with the representation across 16 different countries. Apart from the novelty of the evidence itself and the large sample size, our study explores the impact of policy responses against COVID-19 pandemic on the change of eating habits by using a validated questionnaire (MEDAS) that allow the comparisons of the dietary patterns between European countries. Regarding limitations, the cross-sectional nature of the studýs design does not allow us to establish a causal relationship between the relative stringency of the measures and MedDiet adherence. However, we were able to explore the effect of these measures on the change of the MedDiet adherence due to the confinement. Also, this study recruited participants via non-random snowball sampling method and used a self-reported dietary and lifestyle assessment instrument, therefore overreporting and underreporting might have occurred for certain food items, as well as the social desirability which might have resulted in the higher level of physical activity reported. In fact, majority of respondence were women (77.6%) and had high educational levels (75.2%) and the ethnicity was not considered, which might not be a representative of the general population and could potentially explain higher adherence to the MedDiet among this particular population strata (Cavaliere, De Marchi, & Banterle, 2018). However, the situation limited the employment of a better tool. In addition, the SI was based on various other factors, rather than the confinement itself. Since it was not possible to analyse this factor separately, the overall SI was used for purpose of this study (Petherick et al., 2020). Nonetheless, to date SI is the only measure of the level of stringency of the government responses to COVID-19 which allows the comparison of government responses across different countries and the effect those measures might have on the population lifestyle. It is worth mentioning that our study did not focus on evaluating the appropriateness of government measures and for the purpose of this study we have only addressed the impact of the level of imposed restrictions on eating behaviours.

6. Conclusions

The COVID-19 confinement, despite causing significant distress among general population, lead to an improvement in dietary habits among European population as reflected by an increased adherence to the MedDiet. Increased level of stringency of the government responses to COVID-19 pandemic has been associated to an adoption of a healthier dietary behaviour among those affected. Our study also showed an increase in overall dietary quality and more engagement in home cooking. This transition appeared to be seamless, and the increase in the dietary quality was linked to increased engagement in home cooking. Findings from our study also suggested that nutrition transition towards an optimal dietary pattern has taken place in most European countries, and in particular within the Mediterranean region. Lessons learnt from COVID-19 confinement with respect to dietary habits should be implemented within public health interventions. The focus should be towards improving overall dietary quality at the individual level, through enhancement of cooking skills, and encouragement of home cooking and at the policy level, through the implementation of interventions to address population dietary quality. Ultimately, further understanding of the extent to which disease outbreaks affect the quality of the diet of the global population is necessary to alleviate and decrease the burden of COVID-19 and its complications through the improvement in healthy (immune) status, and prevent similar public health crises in the future. For that purpose, studies addressing if dietary changes during the COVID-19 confinement were kept in time are warranted. Additionally, research on the impact of overall dietary patterns and the onset and/or prevalence of COVID-19 disease and its mortality will be needed in the future.

7. Authors' contributions

Esther Molina-Montes: concept, design, data collection, data

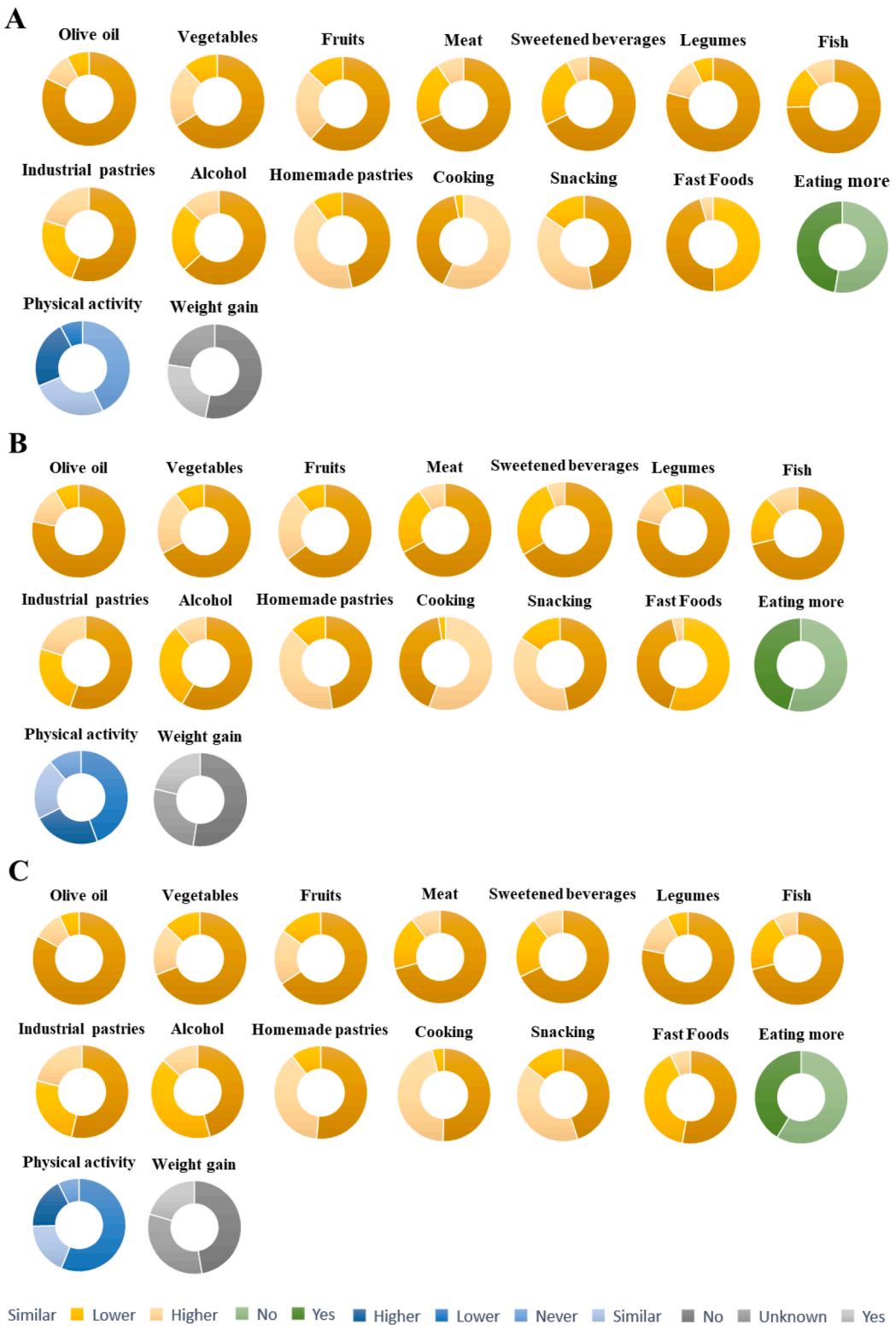

Fig. 4. Dietary intake of MEDAS defined items and other eating behaviours by levels of the SI. Change in the consumption of MEDAS defined items and other eating and lifestyle behaviours by levels of the SI during the COVID-19 confinement in (A) countries with high SI category; (B) countries with very high SI category and (C) countries with medium–high SI category.

analysis and interpretation and writing of the Article; **Irina Uzhova:** data collection, data analysis and interpretation and writing of the Article; **Vito Verardo:** concept, design, data collection and revising the Article; **Reyes Artacho:** concept, design, data collection and revising the Article; **Belén García-Villanova:** concept, design, data collection and revising the Article; **Eduardo Jesús Guerra-Hernández:** concept, design, data collection and revising the Article; **Maria Kapsokefalou:** data collection and revising the Article; **Olga Malisova:** data collection and revising the Article; **Antonis Vlassopoulos:** data collection and revising the Article; **Alexandra Katidi:** data collection and revising the

Table 5
Adherence to the Mediterranean Diet (MedDiet) before and during COVID-19 confinement by categories of the stringency index.

	Very high SI	High SI	Medium high SI	Non-defined
	N = 7898	N = 12039	N = 13536	N = 2712
MedDiet confinement, mean (SD) [a]	5.93 (1.99)	6.01 (2.05)	6.49 (2.06)	5.71 (2.12)
MedDiet confinement levels [a]				
Low	3302 (41.8%)	4856 (40.3%)	4203 (31.1%)	1312 (48.4%)
Medium	3812 (48.3%)	5845 (48.6%)	7123 (52.6%)	1134 (41.8%)
High	784 (9.93%)	1338 (11.1%)	2210 (16.3%)	266 (9.81%)
MedDiet before, mean (SD) [a]	5.01 (1.96)	5.09 (2.01)	5.65 (2.09)	4.46 (2.00)
MedDiet before levels [a]				
Low	4891 (61.9%)	7161 (59.5%)	6555 (48.4%)	1939 (71.5%)
Medium	2663 (33.7%)	4275 (35.5%)	5754 (42.5%)	689 (25.4%)
High	344 (4.36%)	603 (5.01%)	1227 (9.06%)	84 (3.10%)
Change in MedDiet [a]				
Yes	4078 (51.6%)	6142 (51.0%)	6598 (48.7%)	1650 (60.8%)
No	3820 (48.4%)	5897 (49.0%)	6936 (51.2%)	1062 (39.2%)
Difference in MedDiet, mean (SD) [a]	0.92 (1.14)	0.92 (1.16)	0.84 (1.09)	1.25 (1.35)

The adherence to the MedDiet/MEDAS before confinement was estimated using the data on the changes in dietary intake during the confinement compared to the participants' usual intake.
Countries by SI categories: Croatia, Serbia and Italy (very high SI); Bosnia, Greece, Lithuania, Poland, Portugal and Slovenia (high SI); Denmark, Spain, Germany, Turkey (medium–high SI); North Macedonia and Montenegro (non-defined SI).
[a] Significant difference across categories (p-value: <0.001).

Article; **Barbara Koroušić Seljak:** data collection, data processing and revising the Article; **Robert Modic:** data collection, data processing and revising the Article; **Tome Eftimov:** data collection, data processing and revising the Article; **Irena Hren:** data collection, data processing and revising the Article; **Eva Valenčič:** data collection, data processing and revising the Article; **Zvonimir Šatalić:** data collection and revising the Article; **Ines Panjkota Krbavčić:** data collection and revising the Article; **Darija Vranešić Bender:** data collection and revising the Article; **Davide Giacalone:** data collection and revising the Article; **Michael Bom Frøst:** data collection and revising the Article; **Aleksandra Konic Ristic:** data collection and revising the Article; **Jelena Milesevic:** data collection and revising the Article; **Marina Nikolic:** data collection and revising the Article; **Ezgi Kolay:** data collection and revising the Article; **Merve Güney:** data collection and revising the Article; **Vilma Kriaucioniene:** data collection and revising the Article; **Magdalena Czlapka-Matyasik:** data collection and revising the Article; **Aleksandra Bykowska-Derda:** data collection and revising the Article; **Enisa Kujundzic:** data collection and revising the Article; **Irzada Taljić:** data collection and revising the Article; **Muhamed Brka:** data collection and revising the Article; **Igor Spiroski:** data collection and revising the Article; **Sérgio Cunha Velho:** data collection and revising the Article; **Sofia Patrícia Sousa Pinto:** data collection and revising the Article; **Inês Nascimento Monteiro:** data collection and revising the Article; **Janice Adriana Pereira:** data collection and revising the Article; **María Dolores Ruíz-López:** concept, design, data collection, revising the Article and coordination of the study; **Celia Rodríguez-Pérez:** concept, design, data collection, data interpretation and data processing, writing of the Article and coordination of the study. All authors read and approved the final manuscript.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of Competing Interest

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

Acknowledgments

Author would like to extend their gratitude and acknowledgements to all study participants. Vito Verardo thanks the Spanish Ministry of Economy and Competitiveness (MINECO) for "Ramon y Cajal" contract (RYC-2015–18795).

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.foodqual.2021.104231.

References

Abdulah, D. M., & Hassan, A. B. (2020). Relation of Dietary Factors with Infection and Mortality Rates of COVID-19 Across the World. *Journal of Nutrition, Health and Aging*, 1–8.

Ammar, A., Brach, M., Trabelsi, K., Chtourou, H., Boukhris, O., Masmoudi, L., … Hoekelmann, A. (2020). Effects of COVID-19 home confinement on eating behaviour and physical activity: Results of the ECLB-COVID19 international online survey. *Nutrients, 12*, 1583.

Autier, P., Mullie, P., Macacu, A., Dragomir, M., Boniol, M., Coppens, K., … Boniol, M. (2017). Effect of vitamin D supplementation on non-skeletal disorders: A systematic review of meta-analyses and randomised trials. *The Lancet Diabetes and Endocrinology, 5*(12), 986–1004.

Butler, M. J., & Barrientos, R. M. (2020). The impact of nutrition on COVID-19 susceptibility and long-term consequences. *Brain, Behavior, and Immunity, 87*, 53–54.

P.C. Calder Nutrition B.M.J. Nutrition immunity and COVID-19 2020 Prevention & Health 1 19.

Cavaliere, A., De Marchi, E., & Banterle, A. (2018). Exploring the adherence to the Mediterranean diet and its relationship with individual lifestyle: The role of healthy behaviors, pro-environmental behaviors, income, and education. *Nutrients, 10*, 141.

Chaudhry, R., Dranitsaris, G., Mubashir, T., Bartoszko, J., & Riazi, S. (2020). A country level analysis measuring the impact of government actions, country preparedness and socioeconomic factors on COVID-19 mortality and related health outcomes. *EClinicalMedicine, 25*, 100464. https://doi.org/10.1016/j.eclinm.2020.100464

Di Renzo, L., Gualtieri, P., Pivari, F., Soldati, L., Attinà, A., Cinelli, G., … De Lorenzo, A. (2020). Eating habits and lifestyle changes during COVID-19 lockdown: An Italian survey. *Journal of Translational Medicine, 18*, 229.

García-Conesa, M.-T., Philippou, E., Pafilas, C., Massaro, M., Quarta, S., Andrade, V., … Pinto, P. (2020). Exploring the validity of the 14-item mediterranean diet adherence screener (MEDAS): A cross-national study in seven european countries around the mediterranean region. *Nutrients, 12*(10), 2960. https://doi.org/10.3390/nu12102960

Giacalone, D., Frøst, M. B., & 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*, 294. https://doi.org/10.3389/fnut.2020.592112

Górnicka, M., Drywień, M. E., Zielinska, M. A., & Hamułka, J. (2020). Dietary and lifestyle changes during COVID-19 and the subsequent lockdowns among polish adults: A cross-sectional online survey PLifeCOVID-19 study. *Nutrients, 12*(8), 2324.

Grant, W. B., Lahore, H., McDonnell, S. L., Baggerly, C. A., French, C. B., Aliano, J. L., & Bhattoa, H. P. (2020). Evidence that vitamin d supplementation could reduce risk of influenza and covid-19 infections and deaths. *Nutrients, 12*(4), 988. https://doi.org/10.3390/nu12040988

Hale, T., Petherick, A., Phillips, T., & Webster, S. (2020). Variation in government responses to COVID-19. Blavatnik school of government working paper, 31, 2020-11.

Iddir, M., Brito, A., Dingeo, G., Fernandez Del Campo, S. S., Samouda, H., La Frano, M. R., & Bohn, T. (2020). Strengthening the immune system and reducing inflammation and oxidative stress through diet and nutrition: Considerations during the covid-19 crisis. *Nutrients, 12*(6), 1562. https://doi.org/10.3390/nu12061562

Jakobsson, J., Malm, C., Furberg, M., Ekelund, U., & Svensson, M. (2020). Physical activity during the coronavirus (COVID-19) pandemic: Prevention of a decline in metabolic and immunological functions. *Frontiers in Sports and Active Living, 2*, 1–4.

Kriaucioniene, V., Bagdonaviciene, L., Rodríguez-Pérez, C., & Petkeviciene, J. (2020). Associations between changes in health behaviours and body weight during the COVID-19 quarantine in Lithuania: the Lithuanian COVIDiet Study. *Nutrients, 12* (10), 3119. https://doi.org/10.3390/nu12103119

Laguna, L., Fiszman, S., Puerta, P., Chaya, C., & Tárrega, A. (2020). The impact of COVID-19 lockdown on food priorities. Results from a preliminary study using social media and an online survey with Spanish consumers. *Food Quality and Preference, 86*, Article 104028.

L.M. León-Muñoz P. Guallar-Castillón A. Graciani E. López-García A.E. Mesas M.T. Aguilera … F. Rodríguez-Artalejo Adherence to the Mediterranean Diet Pattern Has Declined in Spanish Adults 142 10 2012 2012 1843 1850.

López-Moreno, M., López, M. T. I., Miguel, M., & Garcés-Rimón, M. (2020). Physical and psychological effects related to food habits and lifestyle changes derived from Covid-19 Home confinement in the spanish population. *Nutrients, 12*(11), 3445.

Martineau, A. R., & Forouhi, N. G. (2020). Vitamin D for COVID-19: A case to answer? *The Lancet Diabetes & Endocrinology, 8*(9), 735–736.

Martínez-González, M. A., García-Arellano, A., Toledo, E., Salas-Salvadó, J., Buil-Cosiales, P., Corella, D., … Peiró, C. (2012). A 14-item mediterranean diet assessment tool and obesity indexes among high-risk subjects: The PREDIMED trial. *PLoS ONE, 7*(8), e43134. https://doi.org/10.1371/journal.pone.0043134

Marty, L., de Lauzon-Guillain, B., Labesse, M., & Nicklaus, S. (2020). Food choice motives and the nutritional quality of diet during the COVID-19 lockdown in France. *Appetite, 157*, Article 105005.

Muscogiuri, G., Barrea, L., Savastano, S., & Colao, A. (2020). Nutritional recommendations for CoVID-19 quarantine. *European Journal of Clinical Nutrition, 74* (6), 850–851.

Han, S. N., Meydani, M., Wu, D., Bender, B. S., Smith, D. E., Vina, J., … Meydani, S. N. (2000). Effect of long-term dietary antioxidant supplementation on influenza virus infection. *Journals of Gerontology - Series A Biological Sciences and Medical Sciences, 55* (10), B496–B503.

Peñalvo, J. L., Fernández-Friera, L., López-Melgar, B., Uzhova, I., Oliva, B., Fernández-Alvira, J. M., … Fuster, V. (2016). Association between a social-business eating pattern and early asymptomatic atherosclerosis. *Journal of the American College of Cardiology, 68*, 805–814.

Pierce, M., Hope, H., Ford, T., Hatch, S., Hotopf, M., John, A., … Abel, K. M. (2020). Mental health before and during the COVID-19 pandemic: A longitudinal probability sample survey of the UK population. *The Lancet Psychiatry, 7*(10), 883–892.

Poelman, M. P., Gillebaart, M., Schlinkert, C., Dijkstra, S. C., Derksen, E., Mensink, F., … de Vet, E. (2020). Eating behavior and food purchases during the COVID-19 lockdown: A cross-sectional study among adults in the Netherlands. *Appetite, 157*, 105002. https://doi.org/10.1016/j.appet.2020.105002

R Development Core Team 4.0.1. (2013). A Language and Environment for Statistical Computing. R Foundation for Statistical Computing.

Rodríguez-Pérez, C., Molina-Montes, E., Verardo, V., Artacho, R., García-Villanova, B., Guerra-Hernández, E. J., & Ruíz-López, M. D. (2020). Changes in dietary behaviours during the COVID-19 outbreak confinement in the Spanish COVIDiet study. *Nutrients, 12*(6), 1730.

Rutters, F., Nieuwenhuizen, A. G., Lemmens, S. G., Born, J. M., & Westerterp-Plantenga, M. S. (2009). Acute stress-related changes in eating in the absence of hunger. *Obesity, 17*(1), 72–77.

Sabat, I., Neuman-Böhme, S., Varghese, N. E., Barros, P. P., Brouwer, W., van Exel, J., … Stargardt, T. (2020). United but divided: Policy responses and people's perceptions in the EU during the COVID-19 outbreak. *Health Policy, 124*(9), 909–918.

Schröder, H., Fitó, M., Estruch, R., Martínez-González, M. A., Corella, D., Salas-Salvadó, J., ... & Covas, M. I. (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.

Sidor, A., & Rzymski, P. (2020). Dietary choices and habits during COVID-19 lockdown: Experience from Poland. *Nutrients, 12*(6), 1657.

Smith, K. J., McNaughton, S. A., Gall, S. L., Blizzard, L., Dwyer, T., & Venn, A. J. (2009). Takeaway food consumption and its associations with diet quality and abdominal obesity: A cross-sectional study of young adults. *International Journal of Behavioral Nutrition and Physical Activity, 6*(1), 1–13.

Snuggs, S., & McGregor, S. (2020). Food & meal decision making in lockdown: How and who has Covid-19 affected? *Food Quality And Preference, 89*, Article 104145.

Uchide, N., & Toyoda, H. (2011). Antioxidant therapy as a potential approach to severe influenza-associated complications. *Molecules, 16*(3), 2032–2052.

Wolfson, J. A., & Bleich, S. N. (2015). Is cooking at home associated with better diet quality or weight-loss intention? *Public health nutrition, 18*(8), 1397–1406.

Xu, Y., Li, Z. X., Yu, W. J., Liu, Z., He, X. Y., Ma, Y., … Chen, J. (2020). Impact of the COVID-19 pandemic on willingness to adopt healthy dietary habits in China. *Research Square*, 1–22.