
Dietary and eating behaviours during COVID-19 pandemic: with an emphasis on the impact of self-isolation and quarantine on body weight

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Abstract: The COVID-19 pandemic and its subsequent restrictions have profoundly influenced the lifestyle and eating habits of global citizens, which may affect their body weight. This review aims to explore the effects of quarantine on body weight, eating behaviours, and dietary patterns of adults. This paper reviewed 21 papers with 29,899 participants. The majority of the studied populations did not depict an outlook of unhealthy eating behaviors. A considerable percentage of reviewed populations gained weight, and a relatively higher percentage exhibited emotional eating. Approximately half of the studied populations practised healthy eating. More country-based research is needed during the COVID-19 quarantine.

Keywords: COVID-19; pandemic; eating behaviours; dietary pattern; body weight.

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1 Introduction

Coronavirus or COVID-19 disease is a rampant infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (Renzo et al., 2020). COVID-19 is a highly contagious and hazardous virus with a high rate of morbidity and mortality (Ranasinghe et al., 2020). Since late 2019 when this virus originated in Wuhan, Hubei,

China, the entire world has been experiencing intense panic and stress (Barrea et al., 2020). The World Health Organization (WHO) affirmed COVID-19 as a pandemic on 12 March, 2020 (Haddad et al., 2020). The mutable nature and unpredictable and intricate symptoms of COVID-19 from an “asymptomatic incubation period with or without detectable virus” to a “severe respiratory symptomatic phase with high viral load and inflammation” (Yufang et al., 2020) made it even more challenging for healthcare policymakers. This global pandemic also brought with it a profound impact on people’s life circumstances worldwide.

The health policies to contain the COVID-19 outbreak were wide-ranging from one country to another. Countries are undertaking various strategies to contain the outbreak according to their health infrastructures, and thereby prevent the propagation of the virus. These strategies include adopting measures from the individual level to nationwide measures. The individual measures include physical or ‘social’ distancing, mandatory wearing of masks in public and indoor areas (aiming to prevent human-to-human transmission), self-hygiene, contact tracing, isolation, testing, monitoring, and boosting the immunity of individuals; highly restrictive nationwide measures include quarantine, lockdown, or stay-at-home ordinances (Margaritis et al., 2020; Paper et al., 2020; Ranasinghe et al., 2020). Curfew and home confinements enforced by governments are paramount strategies against the COVID-19 outbreak. These strategies constrain or completely eradicate the time of engagement in outdoor activities which potentially encourage a sedentary lifestyle and eventually result in a lack of physical fitness, which may pave the way for developing immunologic and cardiopulmonary issues (Chandrasekaran and Ganesan, 2020; Oni et al., 2020). These strategies are altering individuals’ lifestyles including their sleep patterns, recreational activities, physical activity pattern and more essentially, eating habits of individuals (Antunes et al., 2020). This paper aims to explore the global effects of quarantine/lockdown on eating behaviours, and dietary intake of individuals and their impact on body weight.

1.1 Quarantine/confinement at home and its effect on people’s eating behaviours

Quarantine or confinement at home is shown to be the most efficient measure against the COVID-19 outbreak in the absence of an effective vaccine or a promising treatment. By virtue of its efficiency, one-third of the world population has undertaken the lockdown strategy to mitigate the propagation of the virus and control its morbidity and mortality rate. Daylight exposure deprivation is an immediate result of these measures, which consequently may lead to marked changes in mealtime and sleep patterns of individuals (Haddad et al., 2020). This also can have substantial changes (both positive and negative) in eating behaviours. Human reaction to such restricted measures could vary based on various factors including psychological factors (stress, depression, or fear), economic, or personal factors (Bhat et al., 2020; Bhuiyan et al., 2020; Bodrud-Doza et al., 2020). Individuals may also consider this limitation as an opportunity to positively modify their eating behaviours and lifestyle patterns, or, on the other hand, experience psychological distress which may cause negative eating behaviours relative to weight gain, such as overeating, emotional eating, and other eating disorders.

2 Methods

This systematic review follows the recommended protocol based on guidelines presented in the Cochrane Reviewer's Handbook (Chandler et al., 2019). It covers human studies from the beginning of the COVID-19 pandemic until October 2020 that found in PubMed, EMBASE, and Scopus databases. In order to cover all the potentially relevant papers, broad search terms were used. Furthermore, to include all available research papers relevant to the topic which may exist in the aforementioned databases, the Google Scholar search engine was used. This paper reviewed 21 relevant research papers with 29,899 participants from Saudi Arabia, Poland, Croatia, Italy, Australia, Lebanon, China, Kuwait, USA, Chile, UK, Spain, and an international study.

2.1 Inclusion criteria for selecting studies

This review only included studies published in the peer-reviewed literature. The language of the publications has been restricted to English. The age is limited to adults (i.e., ≥ 18 years of age). All original studies presenting dietary habits and eating behaviours among populations during restricted measures (lockdown/home confinement) against COVID-19 have been included.

2.2 Data collection and analysis

The data extracted from the original studies have been categorised as the following:

- 1 general information of the studies i.e., country, type of study, time of data collection, sample size
- 2 dietary pattern and frequency of eating different foods during home confinement
- 3 common eating behaviours practiced during the quarantine.

The dietary pattern has been presented as the daily frequency of eating different food groups whereas eating behaviours include more main meals (more than 5) most of the time/always, increase in food intake, unhealthy eating/diet/cooking style, more snacking between meals, skipping meals, eating out of control (overeating), fast food eating, emotional eating and, more alcohol drinking.

3 Results and discussion

This section, including its subsections, reports and discusses the details of the papers briefly explained in Table 1. General characteristics of the reviewed studies has been presented in Table 1. The table includes the author name, country/venue of study, type of study, sample size, and information regarding the eating behaviour and eating problems extracted from the reviewed papers.

Table 1 General characteristics of the included studies

No.	Author/Year	Country/Venue	Type of study	Period of data collection	Sample size	Studied indexes and methods of study	References
1	Al-Musharaf (2020)	Saudi Arabia Riyadh	Observational cross-sectional Online survey Google forms	18 May to 28 May 2020	638 Adult women, Age (18–39yrs)	Anthropometrics: Weight, height Emotional eating Dietary pattern	Al-Musharaf (2020)
2	Ammar et al. (2020b)	International*	International online survey Electronic survey (ECLB-COVID19)	April 2020	1047 Adults (54% females)	Nutrition behaviours, diet	Ammar et al. (2020b)
3	Błaszcyk-Bebenek et al. (2020)	Poland	Observational retrospective anonymous online questionnaire	29 April to 19 May 2020	312 Adults 64.1% women Age (41.12 ± 13.05 yrs)	Demographic data Dietary Habits and Nutrition Beliefs Questionnaire	Błaszcyk-Bebenek et al. (2020)
4	Canello et al. (2020)	Italy Northern	Online survey	15 April to 4 May 2020	490 Adults (84% female) 272 active subjects pre-lockdown	Demographic Data Changes of following factors during lockdown: weight, Consumption, Appetite, Food purchases, Food intake, Quality of the diet, Use of supplements	Canello et al. (2020)

Table 1 General characteristics of the included studies (continued)

No.	Author/Year	Country/Venue	Type of study	Period of data collection	Sample size	Studied indexes and methods of study	References
5	Renzo et al. (2020)	Italy	Online survey Questionnaire	24 April to 18 May 2020	602 Adults (79.7% female) Age (18 –79 yrs)	Demographics Anthropometrics Weight Height Eating habits changes, Emotional eating,	Di Renzo et al. (2020)
6	Renzo et al. (2020)	Italy	Online Web-survey	5 April to 24 April 2020	3533 Adults (76.1% females) Age (≥ 12 yrs)	Demographics Anthropometrics: Weight Height Dietary habits Adherence to the Mediterranean diet, Daily intake of certain foods, Food frequency, Number of meals/day	Renzo et al. (2020)
7	Dogaš et al. (2020)	Croatia	Cross-sectional Online survey	25 April to 5 May 2020 (10 days of the COVID-19 lockdown)	3027 Adults (70.3% female)	Self-report questionnaire	Dogaš et al. (2020)

Table 1 General characteristics of the included studies (continued)

No.	Author/Year	Country/Venue	Type of study	Period of data collection	Sample size	Studied indexes and methods of study	References
8	Gallo et al. (2020)	Australia	Observational study	19 March to 21 March 2018; 25–27 March 2019; Online survey: 29 March–3 April 2020	509 Adults (214 males; 295 females) Age (19–27 yrs)	Dietary Intake from ASA 24-h Recall	Gallo et al. (2020)
9	Górnicka et al. (2020)	Poland	Cross-sectional online survey	30 April and 23 May 2020 (only two days)	2381 Adults Age (≥ 18 yrs)	Dietary-lifestyle Data Socio-demographics Data Anthropometric (Self-reported) Weight-Height	Górnicka et al. (2020)
10	Haddad et al. (2020)	Lebanon	Cross-sectional Web-based online survey	3 April and 18 April 2020	407 Adults Age (30.6 ± 10.1 yrs) (51.3% females)	Eating Disorder Examination-(EDE-Q) Questionnaire	Haddad et al. (2020)
11	Hu et al. (2020)	China	Cross-Sectional study Online survey	10 May to 15 May 2020	1033 Adults Age (18–60 yrs) Lifestyle behaviours 4 months before and 4 months after the COVID-19 outbreak	(GWS) questionnaire	Hu et al. (2020)

Table 1 General characteristics of the included studies (continued)

No.	Author/Year	Country/Venue	Type of study	Period of data collection	Sample size	Studied indexes and methods of study	References
12	Husain et al. (2020)	Kuwait	Cross-sectional study Online survey	During partial quarantine of coronavirus pandemic	415 Adults Age (18-73 yrs)	Anthropometric: Weight- Height Demographic Dietary patterns and habits	Husain and Ashkanani (2020)
13	Neill et al. (2020)	Australia	Cross-sectional study Online survey	1 April 2020 continued for 72hrs	515 Adults Australian general public Age (aged > 18yrs)	Distal factors: Demographics, Previous drinking behaviours Proximal factors: Lifestyle factors, Survey after lockdown	Neill et al. (2020)
14	Pellegrini et al. (2020)	Italy	Observational Retrospective Study Questionnaire dissemination method: By email	1 month after the beginning of the quarantine (10th of March, 2020) Questionnaire sent on: 14 April 2020. Returned on: Between 14 April and 21 April	150 Adults (obese individuals attending a weight loss program) Age (18-75 years) Weight loss program: Verbal and written recommendations on: dietary, exercise, and behaviour. Characteristics of personalised	A questionnaire relative to: 1. the weight before and after 1 month of lockdown, 2. changes in dietary habits, 3. conditions potentially impacting on nutritional choices	Pellegrini et al. (2020)

Table 1 General characteristics of the included studies (continued)

No.	Author/Year	Country/Venue	Type of study	Period of data collection	Sample size	Studied indexes and methods of study	References
15	Reyes-Olavarría et al. (2020)	Chile	Cross-sectional Online survey	May and June 2020	700 Adults (172 males; 528 females) Age (18–62 yrs)	Demographics Anthropometrics Food habits;	Reyes-Olavarría et al. (2020)
16	Robinson et al. (2020)	UK	Cross-sectional Online survey	April–May	2002 Adults (61.7% female)	Diet quality, Overeating	Robinson et al. (2021)
17	Rodríguez-Pérez et al. (2020)	Spain	Cross-sectional Online survey	14 March to 29 March	7514 Adults (70.6% female)	Socio-demographic Anthropometrics; Weight Meddiet pattern based on the validated PREDIMED meddiet Adherence Screener (MEDAS)	Rodríguez-Pérez et al. (2020)
18	Sánchez-Sánchez et al. (2020)	Spain	Cross-sectional Online survey	May 2020 into phase I	1065 Adults (72.8% female) Age > 16yrs (82.1% >25yrs)	Anthropometrics: Weight Height (PREDIMED) questionnaire	Sánchez-Sánchez et al. (2020)

Table 1 General characteristics of the included studies (continued)

No.	Author/Year	Country/Venue	Type of study	Period of data collection	Sample size	Studied indexes and methods of study	References
19	Sidor and Rzymiski (2020)	Poland	Cross-sectional Online survey	17 April and 1 May	1097 Adults (95.1% females) Age (18-71yrs) (mean age 27.7 ± 9.0)	Eating and dietary pattern: Daily number of meals Daily number of snacks Frequency of: Food consumption, Breakfast consumption Snacking, Cooking, Anthropometrics (Self-reported); Weight, Height	Sidor and Rzymiski (2020)
20	Wang et al. (2020)	China	Cross-sectional Online survey	23 March to 26 April 2020 Isolation period: 56-95days	2289 Adults (Age > 18yrs)	Demographics Lifestyle behaviours Drinking Food consumption,	Wang et al. (2020)
21	Zachary et al. (2020)	USA	Online Survey	Not mentioned	173 Adults (77 males; 96 females) Age (28.1 ± 12.5yrs)	Demographics Social network questions Factors that contribute to eating questionnaire	(Zachary et al. (2020)

Department of Clinical Medicine and Surgery, Unit of Endocrinology, (Italy); (PREDIMED): Prevention with Mediterranean Diet group; (EDE-Q): Eating Disorder Examination – Questionnaire; (GWS): General Wellbeing Schedule.

*35 research organisations Europe, North-Africa, Western Asia and America.

Table 2 Weight changes of studied populations before and during the quarantine

Author/Year	BMI (kg/m ²) mean ± SD	Weight category (%)					Weight changes (%)		
		Obese	Overweight	Normal	Underweight	Decrease	No change	Increase	No weighing
Al-Al-Musharaf (2020)	23.2 ± 5.0	9.1	18.1	60.4	12.4	NR	NR	NR	NR
Blaszczyk-Bebenek et al. (2020)	27 ± 1.61	13.3	33.6	50.8	2.3	21.72	32.41	45.86	NR
Cancellato et al. (2020)	22.89	19	13	68	NR	16	34	29	16
Cheikh Ismail et al. (2020)	NR	NR	NR	NR	NR	20.9	40.1	31.0	7.9
Renzo et al. (2020)	25.0 ± 5.2	14.0	26.7	57.1	2.2	NR	NR	NR	NR
Renzo et al. (2020)	23.23	9.5	23.0	63.5	4.0	13.9	37.4	48.6	NR
Đogaš et al. (2020)	24.64 ± 4.22	NR	NR	NR	NR	30.7	NR	NR	NR
Górnicka et al. (2020)	NR	10.2	25.8	58.2	5.8	NR	NR	NR	NR
Haddad et al. (2020)	25.08 ± 4.44	12.9	30.8	53.8	2.5	NR	NR	NR	NR
Husain and Ashkanani (2020)	28.52 ± 6.74	33.1	37.2	28	1.7	NR	NR	NR	NR
Pellegrini et al. (2020)	36.6 ± 4.5	NR	NR	NR	NR	NR	NR	NR	NR
Reyes-Olavarría et al. (2020)	25.3	16.43	35.86	47.71	NR	17	51.15	31.85	NR
Robinson et al. (2021)	27.8	31.8	25.4	39.7	3.1	NR	NR	NR	NR
Rodriguez-Pérez et al. (2020)	NR	NR	NR	NR	NR	NR	47.3	12.8	39.8
Sánchez-Sánchez et al. (2020)	NR	11.7	28.1	57.3	2.9	NR	NR	NR	NR
Sidor and Rzymnski (2020)	23.5 ± 4.8	8.6	19.8	63.7	7.9	18	52	30	NR
Wang et al. (2020)	22.3 ± 3.6	NR	NR	NR	NR	NR	NR	NR	NR
Zachary et al. (2020)	27.0 ± 7.6	NR	NR	NR	NR	19	59	22	NR

Not Reported.

3.1 *Weight change during lockdown*

The mean BMI varied between 22.3 ± 3.6 and 36.6 ± 4.5 (kg/m^2), please see Table 2. In the studied populations, the distribution of individual from different weight categories ranged as: 8.6–33.1% (obese), 13–37.2% (overweight), and 28–68% (normal BMI). Only 8 out of 21 reviewed studies have reported the detail about the weight change during the self-confinement. However, a relatively higher percentage (32.41–59%) of the reviewed populations revealed to have no weight change, whereas, 12.8 (Rodríguez-Pérez et al., 2020) to 48.6% (Đogaš et al., 2020) reported weight gain during the quarantine.

3.2 *Consumption of animal protein sources*

Research provides evidence on the association between daily consumption of red meat and abdominal obesity (Dabbagh-Moghadam et al., 2017; Godfray et al., 2018), whereas frequent consumption of seafood has been suggested to reduce energy intake by 4–9%, and in this way contribute to the regulation of energy balance and prevention of obesity (Liaset et al., 2019). Consumption of egg and red meat has not shown a reliable trend during the lockdown. However, the number of studies that provided the information regarding the frequency of consumption of different food groups was not sufficient. Daily consumption of eggs showed a slight increase in Polish (4%) (Błaszczuk-Bębenek et al., 2020), (6%) (Górnicka et al., 2020) and Spanish (1%) (Sánchez-Sánchez et al., 2020) populations. Likewise, red meat consumption varied from 1.6% to 93% and was shown to have an insignificant increase in Polish (6%) (Górnicka et al., 2020), Kuwaiti (1.2%) (Husain and Ashkanani, 2020), and (0.37%) (Sánchez-Sánchez, Ramírez-Vargas, Avellaneda-López et al., 2020) Spanish populations; please see Table 3. The high daily consumption of red meat in the reviewed studies was not surprising due to the culture-bound habit of meat consumption by Europeans. Additionally, consumption of white meat did not show any trend but varied among different ethnicities as expected [Polish: (2.5%) (Błaszczuk-Bębenek et al., 2020); and Italian: (79%) (Cancello et al., 2020) (87.9%) (Reyes-Olavarría et al., 2020)]. However, it showed both insignificant increase and decrease during lockdown as compared to the period before lockdown. Similarly, daily seafood consumption either decreased or increased insignificantly. The reviewed studies did not provide detailed data regarding canned meat and sausage consumption during and before home confinement.

3.3 *Consumption of carbohydrates*

The consumption of sweets and desserts is revealed to have increased among all study populations that have provided data in this regard. However, the differences were negligible except for a Polish population with (17%) increase (Górnicka et al., 2020); please see Table 3. Also, consumption of white bread, pasta and rice has not shown any clear trend. Consumption of these starchy staple foods varies among different ethnicities based on culture, region, and availability. The consumption of these items has shown both small decreases [(3–4%) (Błaszczuk-Bębenek et al., 2020) in Polish, and Spanish (Sánchez-Sánchez et al., 2020) populations]. In the Spanish population, this reduction might be due to the substantial increase in the price of such items (Sánchez-Sánchez et al., 2020).

3.4 Consumption of fruits and vegetables

Consumption of fruits and vegetables before and during quarantine was high except for the Spanish population (Vegetable: ~9; Fruit: ~14) (Sánchez-Sánchez, Ramírez-Vargas, Avellaneda-I et al., 2020); please see Table 3. Although fruit and vegetable intake have shown both increase and decrease in the studied populations, it is not exhibiting a reliable trend.

3.5 Consumption of grains and nuts

Pulses are rich fibre, relatively low energy-dense foods with approximately 1.3 Kcal/g, despite the fact that ~50–60% of their weight consists of carbohydrates (Ferreira et al., 2021). This will make pulses and legumes good candidates for consumption. Different ethnicities showed a broad range of consumption of these fibre-rich foodstuffs, from 1.6 (Błaszczuk-Bębenek et al., 2020) to 93% (Rodríguez-Pérez et al., 2020); please see Table 3. However, the data shows that higher percentages of studied populations practiced a healthy habit of consumed legumes and pulses either daily or weekly. The increase and decrease in consumption among different studied populations was insignificant, and it does not suggest any trends. Although all the studies have not provided information regarding the frequency of consumption of whole grains, legumes and pulses, and nuts, it is obvious from the available data that the studied populations have had a satisfactory dietary pattern from the consumption of whole-grain products standpoint.

3.6 Consumption of milk and dairy products

Milk and dairy products were also consumed by a higher percentage of the studied populations. The consumption of milk and dairy products increased by 12.6% in a Polish population (Górnicka et al., 2020), however, it showed insignificant decrease in other populations [Italian (−0.2%)(Canello et al., 2020); Kuwaiti (−0.4)(Husain and Ashkanani, 2020); Spanish (Sánchez-Sánchez et al., 2020)(−0.75)] compared to pre-lockdown period; please see Table 3. The consumption of milk and dairy products is important due to their anti-obesity properties. As home confinement may encourage a sedentary lifestyle, incorporating the food groups with anti-obesity properties could counteract the adverse effects of a sedentary lifestyle to some extent.

3.7 Consumption of drinks

Data regarding drinks including energy drinks and fruit juice is insufficient, with only a few studies providing data. Alcoholic beverage intake varied from 3 to 89.6% during confinement; please see Table 3. Consumption of alcoholic beverages has been revealed to show an insignificant decrease, except for a Spanish population (Rodríguez-Pérez et al., 2020) with a 14% increase. However, it shows that the drinking habit of the studied populations remained similar despite the psychological complications due to the pandemic's restrictions and confinement.

3.8 Consumption of chips and salty snacks

It is obvious from the reviewed papers that consumption of chips and salty snacks has not been addressed by the majority of the studies. However, in those population studied it varied from 7.8 to 80.3%.

3.9 Unhealthy eating practices

Humans are social beings and require social activities to secure their psychological and physical health (Ammar et al., 2020a). Hence, in absence of out-door activities over a long duration, in order to combat the anxiety and depression developed during quarantine/

self-isolation they may engage in indoor activities. Eating is often an activity that brings with it feelings of comfort and relaxation (Ammar et al., 2020b).

Literature on the influence of lockdown on eating and lifestyle behaviours is inconsistent and disparities are viewed in factors that have been discussed as representatives of eating practices. However, in this review, the negative or positive effects have been presented as healthy and unhealthy eating. Eating behaviour is a broad concept that encompasses various food choices and motives, nourishing-related activities, dieting practices (La Caille, 2013). The types of food choices made, number of meals per day, snacking, and meal skipping are examples of normal eating behaviours that could be further classified as healthy and unhealthy eating practices. They are common eating practices among humans. Healthy or unhealthy are broad and to some extent generic concepts, that encompass numerous eating behaviours. However, the WHO has declared the characteristics of a healthy diet (WHO, 2020). On the contrary, having a high-fat, high-sugar diet, eating unhealthy snacks (i.e., fried items, chips, sweets, salty and savoury energy-dense snack items), eating street foods especially fried items, more meat-based meals, absence or lack of sufficient fruits incorporated in the diet, etc. (Sun, 2010) are characteristics of an unhealthy diet. The concept of unhealthy eating may vary based on the health of individuals. However, the concepts used in this review have relied on conceptual terminologies used in the original research papers and definitions used as healthy and unhealthy. The main unhealthy eating behaviours which have been reviewed in this paper are presented in Table 2. These unhealthy eating practices have been categorised under the following subheadings.

3.9.1 Number of main meals (≥ 5 meals/day)

The three meal system seems to be a global practice, however, the total number of meals consumed varies in communities. An increase in the frequency of the number of meals consumed per day in association with obesity and weight gain is still controversial. Besides, the frequency of consumption of meals per day alone could not indicate healthy or unhealthy eating practices. The frequency of the number of meals consumed per day when this behaviour is supported with information regarding the composition of food and caloric intake would open a more clear insight into the diet quality. However, despite the common dietetic recommendation regarding consumption of smaller portion sizes, and more frequent meals, details of the composition of foods, and caloric intake did not exist in reviewed papers. Four out of 21 reviewed papers provided information on the number of meals per day while revealing a significant increase in percentages of the number of

main meals (more than 5 meals/day) during the home confinement compared to the pre-lockdown period [12% (Ammar et al., 2020b); 32% (Błaszczuk-Bębenek et al., 2020); 4.9% (Cheikh Ismail et al., 2020); and 12.7% (Husain and Ashkanani, 2020)]; please see Table 4.

3.9.2 *Increased food intake*

In general, the quantity of food consumed regardless of the composition of food has shown to be associated with the development of obesity and can be considered as unhealthy eating practices. Food intake is used interchangeably with caloric intake, however, it is more appropriate to use caloric or energy intake. In this review, food intake represents energy intake. It is obvious from the reviewed studies that the Polish study populations included in the present review had significantly increased their food intake: 29% (Cancello et al., 2020) and 20.2% (Górnicka et al., 2020); please see Table 4. Similarly, Chilean populations were also revealed to have a relatively significant increase in food intake during home confinement (51.3%) (Reyes-Olavarría et al., 2020) and Spanish (37.5%) (Rodríguez-Pérez et al., 2020).

3.9.3 *Unhealthy eating/cooking styles*

Unhealthy eating is an unspecific and broad concept that can encompass many eating practices. However, in the present review, definition and use of this concept has been borrowed from the original papers. Unhealthy eating during the lockdown varied from (10%) (Ammar et al., 2020b) in a multiethnic population to (70.6%) (Rodríguez-Pérez et al., 2020) in a Spanish population. International research including the collaboration of 35 research organisations (Ammar et al., 2020b) revealed a 10% increase in the consumption of unhealthy foods. This investigation had unhealthy eating as never, sometimes, most of the time, and always for both before and during the confinement. The before and after unhealthy eating practices is the sum of the percentage of 'most of the time' and 'always' for before and during the home confinement. (19%) (Górnicka et al., 2020), (26.7%) (Reyes-Olavarría et al., 2020), (35.8%) (Renzo et al., 2020), (49%) (Robinson et al., 2021) of Polish, Chilean, Italian and English population respectively practiced unhealthy eating/cooking styles during home-confinement; please see Table 4.

3.9.4 *Eating outside home: delivery and takeaway*

A high frequency of eating outside home by placing orders for delivery or takeaway per week is considered as an unhealthy eating practice as it is less balanced from the contribution of calories and nutrients standpoint (Mancini et al., 2016) and also shown to be associated with an increase in body weight (Bhutani et al., 2018; Seguin et al., 2016) Regardless of studies supporting this association, still the research on the association of frequently eating outside in a restaurant or eateries and obesity is inconsistent; it could be due to the cultural differences and lack of a consensus on a unified definition of outside eating. Outside eating is equal to both restaurant and fast-food eating in many investigations. In many western countries eating outside the home is a common culture, moreover; the quality of eating foods in sit-down restaurants is close to dishes prepared at home. Here we have separated junk food eating from outside home eating, as restaurant foods in most of the countries serve traditional staple foods whereas junk food mostly

represents cheap, easily accessible and unhealthy foods of low nutritional value and are found either in fast food restaurants or vending machines (Leung et al., 2018). Research that focused on outside eating during quarantine does not show any clear trend one way or the other; it showed a relatively small increase (3.0%) in a Polish population (Błaszczuk-Bębenek et al., 2020), to a substantial decrease (−12.5%) in a study from Kuwait and (23%) in UAE; please see Table 4. On the other hand, on the contrary to a relatively lower percentage of the population eating outside in an Italian study group (Reyes-Olavarria et al., 2020), 60.4% of a Spanish population stated to eat outside frequently (Rodríguez-Pérez et al., 2020).

3.9.5 More snacking between meals

Snacking as an extra eating occasion beyond the normal mealtimes is a global eating practice. Snacks contribute at least one-third of daily calorie intake among the snackers (Hess et al., 2016; Njike et al., 2016). Likewise, like other eating behaviours, snacking can be considered as healthy or unhealthy eating practice (Mattes, 2018). In this work, snacking represents unhealthy and salty snacks. More snacking is practiced by relatively higher percentages of reviewed populations (Robinson et al., 2021; Rodríguez-Pérez et al., 2020; Sidor and Rzymiski, 2020; Zachary et al., 2020); please see Table 4. It is obvious from the findings that snacking increased significantly in studies that have provided the before and during results (Ammar et al., 2020b), except for a Polish population with a negligible decrease (Górnicka et al., 2020).

3.9.6 Skipping meals

Meal skipping is a common practice among all age groups especially high among adolescents and young adults (Nas et al., 2017; Pendergast et al., 2016). Meal skipping also occurs more frequently among those who live alone. Missing a meal followed by a compensatory action of consumption of big portions in the next meal increases the risk of obesity and diabetes type II. Skipping at least one meal occurred in higher percentages of the reviewed populations. It varied from (17.5%) (Renzo et al., 2020) to (94.5%) (Husain and Ashkanani, 2020); please see Table 4. However, it showed a small decrease in UAE (19.3%) (Cheikh Ismail et al., 2020), and Kuwaiti (1.9%) (Husain and Ashkanani, 2020) populations and a small increase (3.1%) (Hu et al., 2020) in Chinese populations during the quarantine.

3.9.7 Uncontrolled eating (Overeating)

Uncontrolled eating is used as an umbrella term that covers all associated psychological constructs. They are measured via questionnaires by examining various types of overeating. It shows a stronger association with increased food intake when measured by scales for disinhibition eating rather than scales for measuring emotional eating (Vainik and Garc, 2019). In this review overeating or eating out of control has been used as its use in original sources in papers. It varied from (0.2%) (Gallo et al., 2020) to (30%) (Ammar et al., 2020b) during the quarantine. A decrease of (1.6%) appeared in a study from Poland (Błaszczuk-Bębenek et al., 2020), while on the contrary, a considerable increase (18%) was observed in an international study (Ammar et al., 2020b); please see Table 4. However, the number of studies that have discussed overeating was insufficient for conclusive inferences.

Table 4 Unhealthy eating behaviours practised during COVID-19 extracted from reviewed studies (%)

References	Before and during lockdown	More Number of main Meals (≥ 2) most of the time/always	Increase in Food intake	Unhealthy eating/diet/cooking style	Eating outside home/place order/take away	More Snacking	Between meals	Skipping meals (breakfast/lunch/dinner)	Eating out of control (over eating)	Fast food eating	Emotional eating (moderate to high)	Night eating	More alcohol drinking
Almandoz et al. (2020)	D	-	-	-	-	-	-	-	-	-	52.8	-	-
Ammar et al. (2020b)	B	7	-	24.61	-	20.82	-	-	12.03	-	-	-	2.19
	D	19	-	34.19	-	39.72	-	-	30	-	-	-	1.4
	C	12	-	9.58	-	18.9	-	-	17.97	-	-	-	-0.79
Blaszczyk-Bebenek et al. (2020)	B	19.9	-	-	45.5	72.8	-	-	3.5	0.3	-	-	-
	D	31.1	-	-	48.4	77.9	-	-	1.9	0.6	-	-	-
	C	-6.8	-	-	2.9	5.1	-	-	-1.6	0.3	-	-	-
Raffaell Cancelllo et al. (2020)	B	-	58	-	-	-	-	-	-	-	-	-	-
	D	-	87	-	-	-	-	-	-	-	-	-	-
	C	-	29	-	-	-	-	-	-	-	-	-	-
Cheikh Ismail et al. (2020)	B	2.1	-	-	28.6	-	-	-	-	26.7	-	-	-
	D	7.0	-	-	5.7	-	-	-	-	7.9	-	-	-
	C	4.9	-	-	-22.9	-	-	-	-	18.8	-	-	-
Renzo et al. (2020)	D	-	-	-	-	-	-	-	-	-	48.7	-	55.1
Renzo et al. (2020)	D	-	-	35.8*	-	-	-	17.5	-	-	-	-	-

Table 4 Unhealthy eating behaviours practised during COVID-19 extracted from reviewed studies (%) (continued)

References	Before and during lockdown	More Number of main Meals (>5) most of the time/always	Increase in Food intake	Unhealthy eating/diet/cooking style	Eating outside home/place order/take away	More Snacking Between meals	Skipping meals (breakfast/lunch/dinner)	Eating out of control (overeating)	Fast food eating	Emotional eating(moderate to high)	Night eating	More alcohol drinking
Pellegrini et al. (2020)	D	-	-	-	13.3	21.3	-	-	-	-	12	-
Reyes-Olavarria et al. (2020)	D	-	51.3	26.7	-	-	-	-	12.1	-	-	30
Robinson et al. (2021)	D	-	-	49	-	56	23	-	-	42	-	36
Rodríguez-Pérez et al. (2020)	B	-	-	-	-	-	-	-	94.9	-	-	-
	D	-	37.5	70.6	60.4**	37.6	-	-	65.1	-	-	10.4****
	C	-	-	-	-	-	-	-	0.2	-	-	-
Sánchez-Sánchez et al. (2020)	B	-	-	-	-	-	-	-	-	-	-	8.10
	D	-	-	-	-	-	-	-	-	-	-	3.10
	C	-	-	-	-	-	-	-	-	-	-	-5
Sidor and Rzymiski (2020)	D	-	43.5	-	-	51.8****	34.5	-	1	-	-	14.6
Wang et al. (2020)	D	-	-	-	-	-	-	-	-	-	-	-
Zachary et al. (2020)	D	-	-	-	-	65.32	-	4.05	-	47.7	-	-

B: Before, D: During, C: Changes. Note: *37.4% ate healthier foods, whereas 16.7% improved their eating habits, **20.9% had more than 3 meals out of home; *** percentage of participants who increased their alcohol consumption; **** tendency for eating more and snacking observed among obese/overweight. All differences were statistically significant ($P < 0.005$).

3.9.8 Fast food eating

Fast food eating has shown a considerable decrease during lockdown [(3.4%) (Husain and Ashkanani, 2020); (19%) (Cheikh Ismail et al., 2020); (28.5%) (Górnicka et al., 2020); and (30%) (Rodríguez-Pérez et al., 2020)], except for a study with a slight increase (0.3%) (Błaszczuk-Bębenek et al., 2020); please see Table 4. Although few studies provided the details concerning consumption of fast foods, it induces a low consumption pattern during the quarantine.

3.9.9 Emotional eating

The propensity towards overconsumption in response to negative emotions is called emotional eating (Frays and Knäuper, 2018). During home-confinement people are more susceptible to eat more to overcome their feelings of fear, uncertainty, and anxiety created by pandemics (Khubchandani et al., 2020). A review of papers collected revealed that a relatively higher percentage of populations exhibited emotional eating [(52.8%) (Almandoz et al., 2020); (48.7%) (Renzo et al., 2020); (47.7%) (Zachary et al., 2020); and (42%) (Robinson et al., 2021)]; please see Table 4.

3.10 Healthy eating practices

The so-called healthy practices include all positive eating-associated decisions including choosing, purchasing, and eventually, eating behaviours. In nutrition, the term *healthy* should be specified for a certain health condition. However, in general, healthy eating practices represent eating practices that prevent common health-threatening complications such as obesity, metabolic syndrome, diabetes mellitus, and cardiovascular diseases. In this paper, because obesity is a potential predisposition for all other aforementioned health complications, and due to the definition of *healthy* as applicable, then incorporating more vegetables and fruits, legumes and pulses, and whole-grain cereals in the diet, while reducing the consumption of high calorie-dense foods, eating less sugar, consuming more low-fat foods and adhering to healthy diets such as the Mediterranean diet will go a long way to improve and maintain our overall health and help boost the immune system, which, in this time of global pandemic is essential. Avoiding unhealthy snacks (i.e., chips, sweets, salty and savoury snack items, etc.), establishing a routine meal time pattern, reducing the frequency of restaurant or fast food eating occasions, watching the meal portion size and maintaining control over eating are all beneficial actions that people of all means can employ in order to achieve the end result of having a healthy life, with nutrition playing a key role. Unfortunately, it has always been easy to rely on easy eating behaviours rather than being vigilant in employing nutritious ones. These negative eating behaviours include high-fat high sugar diets, eating unhealthy snacks (i.e., fried items, chips, sweets, salty and savoury energy-dense snack items), eating street foods, especially fried items, more meat-based meals, and an absence or lack of sufficient fruits incorporated in the diet. Only 10 out of 21 studies revealed that adults during quarantine have made health-friendly changes and have taken the most distressing period of this century and turned it into an opportunity in favour of their health. The four principle healthy eating behaviours can be classified as:

- 1 eating more vegetables and fruits (Hu et al., 2020; Wang et al., 2020)
- 2 decrease consumption of unhealthy food/ fast food (Błaszczuk-Bębenek et al., 2020; Husain and Ashkanani, 2020)
- 3 adhere to healthy diets, such as the Mediterranean diet, and incorporate a pro-healthy pattern of eating into one's daily life (Górnicka et al., 2020; Renzo et al., 2020; Rodríguez-Pérez et al., 2020; Sánchez-Sánchez et al., 2020)
- 4 increase the number of freshly made main meals (Husain and Ashkanani, 2020).

4 Conclusion

The COVID-19 pandemic has become a continuing universal concern and countries are experiencing different waves of COVID-19. The complexity of the nature of COVID-19 also gave rise to the mutation of COVID-19 resulting in new mutants/variants of this virus, exacerbating the situation even more. Until the vaccination of the majority of the world's population is achieved, countries may undergo different phases of quarantine. On the other hand, the association of a well-balanced diet in boosting the immune function signifies the importance of nutrition as a high priority need. Healthy eating practices and a balanced diet are also essential for weight management in the absence of physical exercise facilities during quarantine/home confinement. The present review aimed to explore weight changes, dietary patterns, and eating behaviours of individuals during the COVID-19 home confinement/quarantine.

Despite the multifactorial etiology of obesity and body weight gain, the present work focused on nutritional factors in association with body weight. This paper revealed that a considerable proportion of the studied populations exhibited an increase in body weight. Primarily this can suggest supportive strategies to increase the accessibility of budget-friendly, healthy foods at national levels for all, especially for low socioeconomic classes and more vulnerable groups. Likewise, it raises the need for developing educative programs in order to increase awareness regarding obesogenic dietary patterns and eating behaviours during the current COVID-19 era and future similar global catastrophes. Another direction for further research is to conduct additional country-based studies in order to have a broader national understanding of the dietary patterns and eating behaviours in response to restricted measures like home confinement. This would help towards performing more comprehensive global research in this field during the presence of COVID-19, as well as better management of possible global catastrophes of a similar nature.

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