



COVID-19 Self-quarantine and Weight Gain Risk Factors in Adults

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Abstract

Purpose of Review The COVID-19 pandemic is associated with weight gain in certain individuals. This review highlights the risk factors for weight gain during COVID-19 self-quarantine in adults.

Recent Findings Among those who have gained weight during COVID-19 self-quarantine, self-reported body weight has increased between .5 and 1.8 kg (\pm 2.8 kg) after just 2 months of quarantine. Identified risk factors for weight gain during COVID-19 self-quarantine are the following: increased sedentary behaviors, decreased physical activity, increased snacking frequency (particularly after dinner), increased alcohol intake, decreased water intake, emotional eating, decreased sleep quality, and being overweight/obese.

Summary Having identified risk factors for weight gain during the COVID-19 pandemic, practitioners and researchers should devise plans to assist those who have gained weight to re-learn weight management/weight loss strategies.

Keywords COVID-19 · Pandemic · Self-quarantine · Weight gain

Introduction

On January 30, 2020, the WHO declared the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus that causes the novel coronavirus disease 2019 (COVID-19) pandemic, a global health emergency [1]. Statistical modeling indicated that without mitigation, COVID-19 would have afflicted more than 60% of the US population [2]. Many health organizations such as the US Centers for Disease Control and Prevention [3] and the WHO [1] have issued safety recommendations to reduce exposure to and transmission of the virus. Social distancing, self-quarantine, and widespread shutdowns were imposed to flatten the epidemic curve. The hope was to curb the effects the virus may have had on the healthcare system, morbidity, and mortality [4]. This directive caused grade schools, universities, parks, gyms, and any non-essential business to close. Nonetheless, roughly 12 months after the first

lockdown was announced, COVID-19 mitigation strategies continue.

The extended self-quarantine, widespread shutdown duration, and adverse psychological reactions to the pandemic have brought speculation of an unintended consequence of weight gain [5–7]. The literature has revealed both weight gain and weight loss during COVID-19 self-quarantine [8, 9]. After 2 months of COVID-19 lockdowns, for those reporting weight gain, self-reported body weight increased anywhere between .5 and 1.8 kg [7, 10–12]. Of greater significance, the weight-gain standard deviations are upwards of 2.8 kg [12]. Such large standard deviations suggest that some have gained roughly 11 kg during a relatively short time of self-quarantine imposed by the COVID-19 pandemic. This data collectively suggests that the COVID-19 pandemic provokes large amounts of weight gain in some but not all persons.

The unintended consequence of weight gain from COVID-19 is of immense societal importance. Reports show that the COVID-19 virus more adversely impacts people with obesity than normal weight [13]. Thus, weight gain from COVID-19 self-quarantine could lead to a worsening COVID-19 prognosis. Furthermore, COVID-19 weight gain could be a catalyst for two public health pandemics colliding [14]. Numerous studies have now been published looking at weight gain risk factors from COVID-19 self-quarantine. Thus, the purpose of this review is to highlight the risk factors of weight gain during

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the COVID-19 pandemic in adults. For purposes of this article, data dealing with COVID-19 and weight gain in children will not be included.

Physical Activity Behaviors

Table 1 summarizes the amount of weight gained per study and the risk factors identified.

Sedentary Behavior

Researchers report an overall increase in sedentary behaviors during COVID-19 self-quarantine. A cross-sectional study of 37,252 participants from France found that 63.2% reported increased sedentary time, with an average of 7 h per day spent sitting during lockdown [10]. An online survey of 1047 participants encompassing Europe, North Africa, Western Asia, and the Americas revealed that COVID-19 home confinement had harmed all physical activity levels (vigorous, moderate, walking, overall), but the most notable change was a 28.6% increase in the hours per day sitting [15]. Increased sedentary behavior during COVID-19 self-quarantine can be, at least partially, caused by increased screen time. An observational study ($n = 1970$) from eighteen countries within the Middle East and North Africa showed that people spending more than 5 hours per day in front of a screen for entertainment purposes increased from a pre-COVID-19 level of 14.6 to 37.5% during the COVID-19 pandemic [16].

In addition, reports show an overall decrease in walking during COVID-19 self-quarantine [17]. Physical activity behavior data were released during the COVID-19 pandemic by Fitbit, Inc. This data included the average step counts of more than 30 million users and showed a significant decline in step count, which varied across nations, ranging from a 7 to 38% decrease during the week ending March 22, 2020, as compared with the same period last year [18].

Reports that ran regression models to determine predictors of weight gain during COVID-19 self-quarantine found that both increased television viewing and time spent in sedentary behaviors predicted weight gain [8, 10, 19, 20]. For instance, in a Spanish sample ($n = 1000$), those who gained weight reported that one of the top reasons was decreased physical activity [21]. Additionally, in a study of 700 Chileans, it was shown that more than 6 hours per day of sedentary time predicted weight gain (OR: 1.85, $p = 0.01$) while active breaks were associated with weight loss (OR: 0.72, $p = 0.04$) during the COVID-19 pandemic [8]. Pre-COVID-19 data has revealed that watching television is associated with increased snacking frequency of energy-dense foods, fast foods, and soda [22]. Thus, weight gain from screen time may be magnified by the unhealthy dietary habits that frequently accompany prolonged television viewing [23]. Moreover, a

sedentary lifestyle may decrease resting energy expenditure by 10 to 50% [24].

Exercise

COVID-19 self-quarantine has negatively affected all physical activity levels (vigorous, moderate, overall) [15]. Large datasets from Australia ($n = 5469$), Spain ($n = 2447$), and France ($n = 37,252$) report that 43 to 61% of the population decreased physical activity during COVID-19 self-quarantine [10, 25, 26]. Additionally, it has been found that participants reporting decreased physical activity levels were also those reporting the longest time spent seated [10]. Thus, even though sedentary behavior and exercise are two separate confines concerning weight loss, COVID-19 self-quarantine may provoke parallel deleterious changes in both. Interestingly, some data suggest that those who maintained or increased physical activity during self-isolation were more than likely to have been active before the pandemic. For instance, a study of Italian participants ($n = 3533$) found that exercise frequency increased in those who already took part in sports while those who did not exercise prior did not start [27]. It could be that COVID-19 self-quarantine reinforced prior behaviors.

Regression models revealed that an overall decreased exercise volume was a predictor of weight gain during COVID-19 self-quarantine [10, 28]. Indeed, cross-sectional data ($n = 1970$) from the Middle East and North Africa found that of those who trained more than three times per week, 25% lost weight during the pandemic, while 36% of those who trained less than this reported weight gain [16]. Additionally, within Lithuanian participants ($n = 2447$) who gained weight during the COVID-19 self-quarantine, 85.2% decreased their physical activity levels [25]. Conversely, the dataset from Chile revealed that exercising four or more days per week was associated with weight loss during the COVID-19 pandemic (OR: 0.51, $p = 0.001$) [8]. The ability of physical activity to halt weight gain is well supported [29]. Indeed, low physical activity levels negatively interact with body fat and appetite [30].

Dietary Changes

A healthy, planned diet is an integral part of personal risk management during pandemics such as COVID-19 [31]. It seems, however, that controlling total food intake during the COVID-19 pandemic has been problematic. Many studies show that those who gained weight during quarantine reported greater overall food intake [12, 21, 25, 28]. Additionally, the diet quality of those who gained weight has changed negatively [21, 25, 32]. For instance, decreases in fruit and vegetable consumption [16, 25] and increases in sugary drink consumption [21, 25], as well as increased processed foods [21, 25],

Table 1 Predictors of weight gain during COVID-19

Authors	Sample size	Location	Weight gain	Method of weight measurement	Timeframe of measurement	Risk factors for weight gain
Reyes-Olavarria et al.	700	Chilean national territory	31.8% of sample reported weight gain	Self-administered questionnaire asking about weight before and after confinement (no change, increase, or decrease)	May–June 2020	<ul style="list-style-type: none"> • Separated marital status (OR: 3.33, 95% CI: 1.53–7.24, $p = 0.002$) • Lower socioeconomic level (OR: 1.48, 95% CI: 1.04–2.10, $p = 0.027$) • Consumption of fried foods ≥ 3 times per week (OR: 3.36, 95% CI: 1.77–6.4, $p < 0.001$) • Low water consumption (OR: 1.58, 95% CI: 1.03–2.41, $p = 0.03$) • Junk food ≥ 3 times per week (OR 1.76, 95% CI: 1.02–3.0, $p = 0.04$) • Sedentary time (≥ 6 h/day) (OR 1.85, 95% CI: 1.13–3.03, $p = 0.01$) • Decreased education (β: -1.15, 95% CI: -2.13, -0.17, $p = 0.022$) • Self-reported anxiety/depression (β: 1.61, 95% CI: 0.53–2.69, $p = 0.004$) • Not consuming healthy foods (β: 1.48, 95% CI: .19–2.77, $p = 0.026$) • Increased total food intake ($r = 0.406$, $p < 0.001$) • Snack and drink intake ($r = 0.344$, $p < 0.001$) • Decreased physical activity ($r = 0.102$, $p = 0.002$) • BMI status before the COVID-19 outbreak ($r = -0.161$, $p < 0.001$) • Self-reported anxiety from COVID-19 ($r = 0.117$, $p < 0.001$)
Pellegrini et al.	150	Northern Italy	Total sample gained on average 1.5 kg	Self-administered online questionnaire asking participants weight before and weight at the time of the study	1 month into lockdown	
Zhu et al.	889	China	Total sample gained on average 0.5 ± 2.8 kg	Self-administered online questionnaire asking participants weight before and weight at the time of the study	March–April 2020	
Deschasaux-Tanguy et al.	37,252	France	35% of the sample reported weight gain. Within those who gained weight, average weight gain was reported at 1.8 ± 1.3 kg	Self-administered online questionnaire asking participants weight before and weight at the time of the study. Participants were then assigned to stable, increased, or decreased weight group	April–May 2020	<ul style="list-style-type: none"> • Decreased physical activity and increased sedentary time (OR data not provided) • Trouble keeping a regular mealtime schedule (OR data not provided) • Buying fewer fresh products (OR data not provided) • Snacking more than once a day (OR data not provided) • Eating out of boredom and/or due to anxiety (OR data not provided) • Younger age (18–25 when 25–50 is the reference. OR: 1.41, 95% CI: 1.11–1.79) • Gender (men when women are reference, OR: 0.76, 95% CI: 0.71–0.81). • Anxiety (OR: 1.01, 95% CI: 1.00–1.02). • Depressive symptoms (OR: 1.12, 95% CI: 1.11–1.13). • Pre-lockdown diets featuring a higher proportion of ultra-processed foods (OR: 1.06, 95% CI: 1.01–1.12). • Higher BMI status before the COVID-19 outbreak (OR: 1.09, 95% CI: 0.99–1.121).

Table 1 (continued)

Authors	Sample size	Location	Weight gain	Method of weight measurement	Timeframe of measurement	Risk factors for weight gain
Cremasco et al.	3666	Italy	43.3% of the sample reported weight gain. Total sample reported an increase in body weight of 0.4 ± 2.3 kg	Self-administered online questionnaire asking participants weight before and weight at the time of the study	Two months of lockdown (May 2020)	<ul style="list-style-type: none"> • Sedentary behavior (those spending little amount of time in sedentary activity gained $.3 \pm 2.4$ kg while those spending high amounts of time in sedentary activity gained $.4 \pm 2.4$ kg, $p = 0.048$) • Higher BMI status before the COVID-19 outbreak (those assigned as underweight gained $.3 \pm 2.0$ kg, normal weight gained $.7 \pm 1.8$ kg, while those assigned to obese gained $.9 \pm 3$ kg, $p < 0.001$) • Changes in sleep quality (those with positive changes in sleep quality gained 0.0 ± 2.4 kg while those with negative changes in sleep quality gained 0.5 ± 2.5 kg, $p = 0.002$)
Sanchez et al.	1000	Spain	44.5% of the sample reported weight gain. 32.7 reported weight gain increased by 3 kg	Phone interviews and dichotomized as < 3 kg or > 3 kg weight gain	May–June 2020	<ul style="list-style-type: none"> • Female sex (OR: 9.04, 95%CI: 2.87–28.4, $p < 0.001$) • Higher BMI status before the COVID-19 outbreak (OR: 4.70, 95%CI: 1.61–14.10, $p < 0.001$) • The development of the sensation of being hungrier (OR: 8.01, 95%CI: 2.46–26.04, $p < 0.001$) • Increased consumption of sugary drinks and alcoholic beverages and snacks (OR: 4.11, 95%CI: 1.21–13.88, $p < 0.023$)
Zeigler et al.	173	USA	22% of the sample reported weight gain of 5–10 pounds	Self-administered online questionnaire asking if subjects lost > 10 pounds, lost 5–10 pounds, maintained weight, gained 5–10 pounds, gained > 10 pounds	March 2020	<ul style="list-style-type: none"> • Eating in response to sight and smell (a higher % of participants reported “largest increase” for eating in response to sight and smell within the 5–10 lb. weight gain category, $p = 0.048$) • Eating in response to stress (a higher % of participants reported “largest increase” for eating in response to stress within the 5–10 lb. weight gain category, $p = 0.041$) • Snacking after dinner (a higher % of participants reported “largest increase” for snacking after dinner within the 5–10 lb. weight gain category, $p < 0.001$) • Decreased hours of sleep per night ($r = -.195$, $p = 0.021$) • Decreased physical activity time ($r = -.155$, $p = 0.034$)
Kriaucioniene et al.	2447	Lithuania	31.5% of the sample reported weight gain	Self-administered online questionnaire that asked, “Have you gained weight during the quarantine?” with possible answers: “Yes,” “No,” “I don’t know.”	April 2020	<ul style="list-style-type: none"> • Older age (18–35 yr is reference, > 50 yr, OR: 1.80, 95% CI: 1.35–2.39, $p = 0.001$) • Increased consumption of sugary drinks (15% of those who gained weight versus 5.5% of those who did not gain weight $p = 0.001$) • Increased snacking (73% of those who gained weight increased versus 32% who did not gain weight, $p < 0.001$) • Decreased physical activity (85% of those who gained weight decreased versus 57% who did not gain weight, $p < 0.001$)

Table 1 (continued)

Authors	Sample size	Location	Weight gain	Method of weight measurement	Timeframe of measurement	Risk factors for weight gain
Ismail et al.	2970	Middle East and North Africa	30% of the sample reported weight gain	Self-administered online questionnaire. No further detail	April 2020	<ul style="list-style-type: none"> Increased alcohol consumption (21% of those who gained weight increased versus 11% who did not gain weight, $p < 0.001$) Higher BMI status before the COVID-19 outbreak (44% of those classified with obesity gained weight compared to only 25.3% of those classified as normal weight based on BMI) Decreased physical activity (25% of those training >3/week lost weight and 49% maintained their weight ($p < 0.001$); 37 % of people who did not train reported gaining weight)
AlMughamis et al.	522	Kuwait	The entire sample increased on average 1.13 ± 5.35 kg	Self-administered online questionnaire asking participants weight before and weight at the time of the study	April 2020	<ul style="list-style-type: none"> Unhealthy diets (those consuming an unhealthy diet were 4.5 times more likely to increase in weight (95% CI= 2.45–8.23)) Self-reported anxiety (those reporting anxiety were 2.45 times more likely to increase weight) Excessive snack consumption (snack consumption >3 times a day was associated with 3.27 times higher odds of increase weight)
Sidor and Rzymiski	1097	Poland	30% of sample reported weight gain. Within those who gained weight, average weight gain was reported at 3 ± 1.5 kg	Self-administered online questionnaire asking participants weight before and weight at the time of the study	April–May 2020	<ul style="list-style-type: none"> Higher BMI status before the COVID-19 outbreak correlated with weight gain ($r = 0.21, p < 0.001$) Older subjects (> 36 yr) correlated with weight gain ($r = 0.15, p < 0.05$)

have all been reported within those who have gained weight during COVID-19 self-quarantine.

As will be discussed below, increased total caloric intake and increased intake of high-fat, high-sugar, processed foods could be due to the psychological impact the COVID-19 pandemic has been shown to have. Moreover, the type of food purchased during the COVID-19 pandemic has changed compared to pre-pandemic food purchasing [25]. For example, snack foods available during COVID-19 self-quarantine have been reported to change to foods that do not spoil. An article from the UK ($n = 2002$) found an 82% increase in unhealthy food in the home during COVID-19 self-quarantine [33]. Additionally, food consumption data from Italy ($n = 10,769$ stores) reported that during the first 6 weeks of COVID-19 confinement, there was an increase in canned and frozen food consumption and decreased sales of fresh goods and fruits and vegetables [34]. Changing one's diet to adopt negative eating styles has been shown to predict weight gain during the COVID-19 pandemic. For instance, within a sample of 522 participants from Kuwait, compared with respondents who changed their diet pattern to healthier, those reporting unhealthy diets were 4.5 times more likely to report an increase in weight during COVID-19 self-quarantine [32].

Key essential nutrients have also been shown to be deficient during COVID-19 self-quarantine. One particular nutrient of concern in relation to the COVID-19 virus and risk of obesity is vitamin D. An extensive dataset from France revealed that lower intakes of vitamin D during COVID-19 self-quarantine were observed [10]. Vitamin D status is likely already strongly impacted by the lockdown due to increased time being spent indoors. Indeed, most vitamin D being produced is following sun exposure which is not compatible with the requirement to stay home. Furthermore, vitamin D is linked to both obesity and COVID-19 severity [35].

Snacking

The exact amount of caloric increase due to snacking is not provided in the literature. However, a commonly reported theme during COVID-19 self-quarantine is increased snacking frequency [12, 15, 17, 33, 36]. For example, cross-sectional data from 1097 Poles revealed that 52% of participants admitted to snacking more frequently between meals when compared to before the pandemic [37]. Increased snacking may be problematic as pre-pandemic data reveals snacking leads to a positive energy balance [38]. Even a small positive energy balance over time is sufficient to cause weight gain in many individuals [39]. Indeed, increased snacking has been shown to predict weight gain during COVID-19 self-quarantine [21, 25]. One report showed that consuming snacks greater than three times a day during COVID-19 self-quarantine was associated with 3.27 times higher odds of

increasing weight than those consuming snacks less than three times a day [32].

Some studies have also reported that snacking, specifically after dinner, is an independent predictor of COVID-19 self-quarantine weight gain [28]. The link between snacking after dinner and weight gain is well supported in the literature. Emerging data has revealed that a high percentage of adipose tissue is diurnally regulated [40] and that calories consumed later in the day tend to be stored within adipose tissue [41].

Water

In many cases, water consumption during COVID-19 self-quarantine has been reported to have been reduced and often replaced with sugar-sweetened beverages [16, 27]. For instance, cross-sectional data ($n = 1970$) from the Middle East and North Africa revealed that 74% of people reported an inadequate water intake of fewer than eight cups per day [16]. Likewise, in Italy, 87% of surveyed participants reported drinking less than 2 l of water per day, and 26% consumed less than 1 l per day [27]. Moreover, regression analysis reveals that low water consumption is associated with body weight increase during the COVID-19 self-quarantine [8]. Indeed, an increased energy cost is associated with increasing the temperature of ingested water and changes in the osmolarity of the cell [42]. Furthermore, data suggest that water intake may impact the satiety response [43].

Alcohol

Whether or not alcohol intake has increased during COVID-19 self-quarantine is somewhat controversial. Few studies reported increased alcohol consumption and higher drinking tendency among alcohol addicts [10, 37], while other studies reported a decrease in binge drinking and alcohol consumption [9, 15, 27, 44]. Regardless, increased alcohol consumption is a predictor of weight gain during COVID-19 self-quarantine [21, 25]. A sample of Spanish adults revealed that increased consumption of alcoholic beverages was an independent predictor of weight gain during COVID-19 self-quarantine (OR 4.11 (1.21–13.99), $p = 0.023$) [21]. Additionally, researchers from Spain found that increase in alcohol consumption was reported by every fifth participant (20.9%) who gained weight, and every tenth (11.2%) who did not [25].

Increased alcohol consumption during the COVID-19 pandemic was linked with increased depression, anxiety, and stress during confinement in an Australian population [45]. Additionally, evidence has shown that alcohol drinkers are less likely to find anything positive about the COVID-19 pandemic situation and are mentally less able to cope [46]. Thus, alcohol intake may lead to weight gain during the COVID-19 pandemic because of its impact on emotional health. Also, given that 1 g of alcohol provides roughly 7 kilocalories of

energy, it is no surprise that pre-pandemic prospective and longitudinal studies show that excessive alcohol consumption is associated with weight gain [47].

Psychological Impacts on Eating

Increased anxiety, stress, and depression during the COVID-19 pandemic have all been reported [16, 48, 49]. Evidence suggests that the COVID-19 pandemic mandatory self-quarantine per se may trigger these psychological conditions [50]. In addition to self-quarantine, one's occupation [51], whether one has been diagnosed with COVID-19 [52], and misinformation [53] are other reported sources of stress and anxiety. Social media information overload may also provoke stress and anxiety. For instance, one study showed that 82% of participants were regularly exposed to social media, and the increase of exposure frequency was associated with higher odds of anxiety and depression [54].

Furthermore, food choice can be influenced by psychological parameters such as anxiety [55]. Pre-pandemic data suggest that negative emotions predict poor diet and increased intake of saturated fat, energy-dense, and salty foods [56]. Stress specifically can lead to hyperphagia, binge eating, and an alteration of the types of food eaten [57–59]. Pandemic data has revealed that higher stress scores predicted increased caloric intake (OR 1.07 (1.05–1.10), $p < 0.001$) [44]. Additionally, data from a Spanish population revealed that 74% of respondents confessed to having experienced more significant and frequent sensations of hunger than before the lockdown, with anxiety as the top factor related to this perception of increased hunger [21]. These authors reported that the development of hunger sensation was an independent predictor of weight gain (OR 8.01 (2.46–26.04), $p < 0.001$).

Additional data from France revealed that those who gained weight had higher depression and anxiety scores [10]. Further data from Kuwait reported that those with anxiety throughout the day were 2.45 times more likely to increase weight than those never experiencing it during the COVID-19 pandemic [32]. In a sample of 889 participants in China, anxiety from COVID-19 self-quarantine was shown to be a strong predictor of eating and eventual weight gain [12]. Even among obese patients receiving nutritional advice for at least 6 months before the pandemic, those with self-reported anxiety and depression gained more weight than those without during the COVID-19 self-quarantine (3.18 kg vs. 0.49 kg, $p < 0.001$) [7].

Adverse changes in eating behavior could also be due to eating out of boredom. Indeed, boredom has been shown to predict negative eating behaviors [60] and is associated with increased eating during the COVID-19 pandemic [28]. Boredom, stress, anxiety, and depression may lead to emotional eating, contributing to weight gain [61]. For instance,

640 pregnant women in China were asked about emotional eating indices and gestational weight gain during the COVID-19 pandemic [62]. It was found that women who showed a more significant concern about the COVID-19 pandemic had higher emotional eating scores and an increased risk of excess gestational weight gain (OR 1.90 (1.08–3.32), $p < 0.001$).

Demographic Predictors of Weight Gain

BMI

The literature is robust in that nearly every study addressing predictors of weight gain during COVID-19 self-quarantine identifies that individuals categorized as overweight or obese are at higher risk of weight gain [7, 10, 21, 25, 33]. For example, in a sample of 2447 participants from Lithuania, 25.3% of those whose BMI falls within normal (18.5–24.9 kg/m²), 39.3% of those whose BMI falls within overweight (25–29.9 kg/m²), and 43.6% of those whose BMI falls within the obese (>30 kg/m²) category reported weight gain during the COVID-19 self-quarantine [25]. There are many hypotheses as to why individuals with obesity gain disproportionately during COVID-19 self-quarantine. One hypothesis is that individuals with obesity have pre-established habits of buying and consuming calorically dense, processed foods, which are exacerbated by the COVID-19 pandemic. For instance, data from across the USA during COVID-19 self-quarantine showed that populations with a higher percentage of adults with obesity showed greater patronage of unhealthy eating establishments [63]. Pre-pandemic data has shown that areas with a higher density of establishments selling high-calorie fast food and junk food relative to healthier options relate to obesity [64]. Additionally, a sample of 1030 Dutch adults found that people with overweight or obesity report it more challenging to make healthy food choices during COVID-19 lockdown than normal-weight persons [65]. Indeed, having a higher BMI has been associated with increased junk food consumption during COVID-19 self-isolation [37, 63]. Pre-COVID-19 pandemic literature reports that the obese display more problematic eating behaviors such as frequent eating without hunger and eating when bored or lonely, compared to lean [60, 66]. These problematic eating behaviors may be partly due to the higher risk for social isolation and depression during COVID-19 reported in the obese population [14]. COVID-19 data also has revealed that BMI is positively associated with increased appetite after dinner [27]. Late-night snacking, as previously discussed, is an independent predictor of weight gain.

The association between obesity and unhealthy eating during COVID-19 self-quarantine could be moderated by stress [65]. Prior research has demonstrated that stress is associated with obesity and that individuals with obesity are more prone

to stress-induced eating than healthy controls [67]. In addition, those with obesity may also experience stress from weight stigma. Evidence shows that weight stigma affects weight-related health, including lower physical activity and unhealthy eating behaviors and weight gain [68]. Although data suggests those with obesity did not experience increased weight stigma during the COVID-19 pandemic [69], 19–42% of individuals with obesity are discriminated against because of their weight [70]. Indeed, the odds of engaging in binge eating during COVID-19 were nearly three times higher for individuals teased about their weight before the pandemic than those never teased about their weight [71].

Gender

Gender is not a consistent predictor of weight gain during COVID-19 self-quarantine, with some studies reporting no gender differences [12, 27, 37], while others report increased weight gain in women [10, 21, 25]. Using a Spanish sample, researchers reported that the most critical factor related to weight gain was the female gender, with 58% of women versus 46% of men reporting weight gain during COVID-19 self-quarantine [21]. During COVID-19 self-quarantine, females may have a higher risk than males of atypical sleep levels [72]. Additionally, more females than males have self-reported that it is harder to make healthy food choices during self-quarantine [65]. Females also report greater calorie/salty food intake and increased screen time during COVID-19 self-quarantine when compared to males [44]. Increased weight gain among women could also be attributed to their smaller bodies and lower caloric requirements—relative to typical food portions [21].

Age

The impact of age within the adult population on weight gain during the COVID-19 pandemic is unclear. Some datasets show that age does not affect weight gain [12, 25], while some suggest age is a moderating variable [37, 65]. Two studies confirmed that the eating behaviors of older participants (65 years and up) were less likely to change than those of younger adults [65, 72]. On the other hand, a lower age was associated with increased junk food consumption [37, 63] and increased overall appetite during COVID-19 self-quarantine [27]. More data on the possible moderating role of age on COVID-19 self-quarantine weight gain are warranted.

Socio-economic Status

Socio-economic status is another variable that is not entirely consistent in the literature. Some studies suggest that monthly income and education did not predict COVID-19 self-quarantine weight gain [12, 37], while a few studies contradicted

these findings [7, 33]. Although not directly looking at weight gain, data from the UK found that lower education was an independent predictor of less favorable weight management behaviors ($\beta = -.069$, $p = .003$) during COVID-19 self-quarantine [33]. Additional data from across the USA indicated that lower-income counties showed higher patronage of unhealthy eating establishments during the COVID-19 pandemic [63]. The extensive dataset from France indicated that higher incomes were associated with more favorable modifications of nutritional behaviors when compared to lower incomes [10]. Whether or not socio-economic status is a moderating variable between COVID-19 self-quarantine and weight gain is yet to be determined.

Sleep Behaviors

Alterations in sleep patterns have been reported during COVID-19 self-quarantine, with some data indicating that sleep hours have increased [16, 27]. The relationship between sleep duration and weight gain is a U-shaped relationship such that when sleep duration increases beyond a certain level, it then predicts weight gain [73]. Although sleep duration may have increased, sleep during COVID-19 self-quarantine has been reported to be filled with sleep disturbances and poor quality [16, 27, 48]. For instance, one study reported that 63.2% of subjects reported sleep disturbances during the pandemic versus only 53% before the pandemic [16]. Decreased sleep quality independently predicts COVID-19 self-quarantine weight gain [20, 28]. Data from Italy revealed that within the 45% of participants who experienced a worsening sleep quality, an average weight gain of .5 kg was observed [20]. However, in participants who reported increased sleep quality, no weight gain was reported. Pre-COVID-19 pandemic data reveals that decreased sleep quality affects physical functioning during the subsequent day leading to sedentary behaviors [74].

Conclusion

The COVID-19 pandemic increases the risk of weight gain in specific individuals. Identified risk factors for weight gain during COVID-19 self-quarantine are the following: increased sedentary behaviors, decreased physical activity, increased snacking frequency (particularly after dinner), increased alcohol intake, decreased water intake, emotional eating, decreased sleep quality, and being overweight/obese. Average weight gain during the COVID-19 self-quarantine is similar to holiday weight gain [75]. Holiday weight gain may provide insight into unanswered questions about weight gained during the COVID-19 pandemic. For example, we know that weight gained during the holidays is not subsequently lost and that

holiday weight gain contributes to more than half of annual weight gain in adults [76]. It is not clear if weight gained during the COVID-19 pandemic will subsequently be lost. Indeed, the duration of the initial lockdown period might have been sufficient for modified habits to settle in some individuals [77]. For instance, one dataset out of China looked at any possible lingering eating behaviors that stayed after lockdowns were lifted and found that people still followed certain dietary behaviors to cope with the COVID-19 pandemic [78]. Additionally, one study reported that within those who gained weight during COVID-19 self-quarantine, only rarely did they lose weight after peak lockdown eased [75]. Thus, a concern is that COVID-19-related weight increases will add to the annual holiday weight gain in 2020 and 2021, putting people at a greater risk for metabolic disorders. Having identified risk factors for weight gain during the COVID-19 pandemic, practitioners and researchers should devise plans to help those who have gained weight re-learn weight management/weight loss strategies.

A few challenges have emerged within the COVID-19 weight gain literature. First, identifying the exact amount of weight a person may gain during the COVID-19 self-quarantine is difficult as containment strategies are not universal throughout the world. Secondly, the timeframe of body weight being reported varied from one study to another, translating to some participants under self-quarantine guidelines much longer than others. Lastly, almost all data on weight gain and COVID-19 are self-report data. One study showed that many participants think they have gained more weight during COVID-19 than they did [79]. Thus, interpreting weight change data from the COVID-19 pandemic should be done with caution.

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