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# COVID-19 pandemic directly influences food behavior promoting body weight gain

# A pandemia da COVID-19 influencia diretamente o comportamento alimentar, promovendo o ganho de peso corporal

**Fernanda Caroline de Oliveira Arruda**
Mestre em Ciências da Saúde
Instituição: Universidade São Francisco
Endereço: Av. São Francisco de Assis, 218, Jardim São José, Bragança Paulista - SP, CEP: 12916-900
E-mail: fearruda.nutri@gmail.com

**Catarina de Almeida Lustosa**
Graduanda em Enfermagem
Instituição: Universidade São Francisco
Endereço: Av. São Francisco de Assis, 218, Jardim São José, Bragança Paulista - SP, CEP: 12916-900
E-mail: almeidalustosacat@gmail.com

**Samuel Aparecido Zanesco**
Graduando de Enfermagem
Instituição: Universidade São Francisco
Endereço: Av. São Francisco de Assis, 218, Jardim São José, Bragança Paulista - SP, CEP: 12916-900
E-mail: samuelzanesco@hotmail.com

**Emerson Gomes dos Santos**
Doutor
Instituição: Universidade Federal de São Paulo (UNIFESP)
Endereço: Rua Oleska Winogradow, 100, Jardim das Flores, Osasco – SP, CEP: 06110-295
E-mail: emerson.gomes@unifesp.br

**Daniela Soares Razolli**
Doutora em Ciências
Instituição: Universidade São Francisco
Endereço: Av. São Francisco de Assis, 218, Jardim São José, Bragança Paulista - SP, CEP: 12916-900
E-mail: danirazolli@yahoo.com.br

## ABSTRACT

Background and Aims: Obesity is a multifactorial disease affecting approximately 650 million individuals worldwide, and recent studies suggest that obesity is a poor prognostic factor for coronavirus disease (COVID-19). Social restrictions

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during pandemics can impact eat-ing behavior. Herein, we aimed to investigate the impact of altered eating habits during the COVID-19 pandemic, contributing to body weight gain. Methods: This observational study administered an online questionnaire twice to the same volunteers at a six-month interval. In the first and second surveys, 232 and 76 volunteers, respectively, answered questions regarding food intake frequency and habits, physical activity levels, and a per-ception of changes when compared with the pre-pandemic period. Pearson's Chi-square test was performed for each variable, followed by logistic regression analysis. Results: Overweight individuals experienced anxiety, favoring increased fast-food consumption. Logistic regression revealed that as the body mass index (BMI) increased, the potential for body weight gain increased gradually. Moreover, the consumption of legumes was associ-ated with the maintenance or loss of body weight. Conclusions: Collectively, these findings indicated that the social restriction due to the COVID-19 pandemic significantly impacted food intake, promoting changes in body weight gain that could further aggravate the ex-isting obesity epidemic.

**Keywords:** obesity, COVID-19, pandemic, food pattern, body weight gain

## RESUMO

Antecedentes e objetivos: a obesidade é uma doença multifatorial que afeta aproximadamente 650 milhões de indivíduos em todo o mundo, e estudos recentes sugerem que a obesidade é um fator prognóstico reservado para a doença do coronavírus (COVID-19). Restrições sociais durante pandemias podem afetar o comportamento alimentar. Neste documento, visamos investigar o impacto da alteração dos hábitos alimentares durante a pandemia da Covid-19, contribuindo para o ganho de peso corporal. Métodos: Este estudo observacional administrou um questionário on-line duas vezes aos mesmos voluntários em um intervalo de seis meses. No primeiro e segundo inquéritos, 232 e 76 voluntários, respectivamente, responderam a perguntas sobre a frequência e os hábitos de ingestão de alimentos, os níveis de atividade física e a percepção de alterações em comparação com o período pré-pandêmico. O teste Qui-quadrado de Pearson foi realizado para cada variável, seguido por análise de regressão logística. Resultados: Indivíduos acima do peso experimentaram ansiedade, favorecendo o aumento do consumo de fast-food. A regressão logística revelou que, à medida que o índice de massa corporal (IMC) aumentava, o potencial de ganho de peso corporal aumentava gradualmente. Além disso, o consumo de leguminosas estava associado à manutenção ou perda de peso corporal. Conclusões: coletivamente, essas descobertas indicaram que a restrição social decorrente da pandemia da Covid-19 impactou significativamente a ingestão de alimentos, promovendo mudanças no ganho de peso corporal que poderiam agravar ainda mais a epidemia de obesidade existente.

**Palavras-chave:** obesidade, Covid-19, pandemia, padrão alimentar, ganho de peso corporal.

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## 1 INTRODUCTION

Obesity is a multifactorial chronic disease characterized by an excess of adipose tissue depots, compromising health and predisposing individuals to type 2 diabetes, hypertension, cardiorespiratory diseases, stroke, acute myocardial infarction, and several cancers [1–5].

In 2016, it was reported that more than 1.9 billion people over 18 years of age were overweight, and approximately 650 million were obese worldwide, representing approximately 39% of overweight and 13% of obese subjects, and generating costs approximating USD 2.0 trillion to the healthcare system, or 2.8% of the global gross domestic product (GDP) [6,7]. In Brazil, recent data has revealed that 55.4% of Brazilians are overweight and 20.3% are obese, indicating an increase of almost 70% over the last 13 years, contributing to 1.9% of expenses with medium and high complexity healthcare [8,9].

Currently, the coronavirus disease (COVID-19) pandemic caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), a new class of beta-coronaviruses, remains predominant globally. Since the World Health Organization declared the pandemic, scientists have attempted to establish the pathophysiology of the new virus, which until August 2022 has infected 586.750.650 individuals worldwide, with at least 680.166 confirmed deaths reported in Brazil [10,11].

Sudden social restrictions imposed by the pandemic altered routines, distanced family and friends, changed lifestyles and economies, and impacted general health [12]. Consequently, individuals might experience psychological distress, anxiety, and depression, potentially resulting in decreased self-care, reduced physical activity, and increased food consumption [13,14].

Isolation within households facilitates access to pantries and refrigerators, providing *ad libitum* food access throughout the day and night, a scenario that typically differs from the pre-pandemic environment of most individuals [15]. In this context, parallel to the obesity pandemic, the COVID-19 pandemic appears to be another component of obesogenic determinants to be considered in the future.

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It is well-known that a positive energy balance, even for short periods, can lead to dysfunction of the hypothalamic melanocortin system, responsible for satiety [16,17]. If increased food intake continues over time, in addition to weight gain, this dysfunction can lead to apoptosis of anorexigenic neurons, further complicating the control of energy homeostasis and a return to a normal weight status [16].

Accordingly, it is essential to understand how abrupt lifestyle changes can contribute to an imbalance in energy homeostasis and impact body weight gain, favoring obesity. When individuals alter their dietary habits, generating a positive energy balance, it can worsen the actual obesity pandemic, impairing health and quality of life. Therefore, it is crucial to understand how gradual changes in dietary patterns interfere with energy homeostasis and identify aggressive measures to manage obesity precisely.

Hence, we selected volunteers to answer an online survey regarding food intake frequency and habits, physical activities, and perceptions of altered eating behavior during the pandemic when compared with pre-pandemic behaviors. The questionnaire was administered twice to the same individual, at a six-month interval, immediately after periods of considerable restriction and social isolation, as imposed by the Federal Government of Brazil.

We hypothesized that social restriction due to the COVID-19 pandemic increased food intake of selected food types and altered routine habits and emotional feelings, favoring gradual body weight gain.

## 2 MATERIALS AND METHODS

### 2.1 ETHICAL APPROVAL AND PARTICIPANT SELECTION

The present observational study was approved by the Ethical Committee of the Universidade São Francisco (CAAE 36628620.9.0000.5514). The participants were recruited via digital networks, including Facebook®, WhatsApp®, Instagram®, and website divulgation. A letter of invitation was written in the native language, containing the link to Google Forms® for answering the questionnaire. On opening the link, the volunteers accessed the

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informed consent, which had to be mandatorily read and accepted prior to answering the questionnaire. After submission, a copy of the answers was sent automatically to the e-mail address provided by the volunteer.

Inclusion criteria were adult individuals, males and females, aged ≥ 18 or ≤ 60, and body mass index (BMI) ≥ 18.5. Exclusion criteria were as follows: age < 18 years and > 60 years, BMI < 18.5, pregnant or lactating women, severe non-stabilized neurological or psychiatric conditions, use of anti-obesity medication, individuals with untreated neoplasms, and individuals who underwent bariatric surgery <5 years from the questionnaire survey.

## 2.2 STUDY DESIGN

The cross-sectional online questionnaire was structured using the Google Forms® platform and administered at two different time points to the same volunteer, with an interval of six months between the first and the second survey. The first survey was performed in September and October 2020, and the second was performed in March and April 2021 (Figure 1). The volunteers answered a questionnaire regarding anthropometric information, food frequency and habits, self-perceived changes in dietary behavior when compared with pre-pandemic habits, and physical activity. Thereafter, the volunteers were subdivided into groups according to BMI as normal weight (BMI ≥ 18.5, ≤ 24.9), overweight (BMI ≥ 25.0 ≤ 29.9), and obese (BMI ≥ 30).

The food frequency questionnaire was developed following guidelines from other validated and previous questionnaires in Brazil [18,19]. The types of foods used to compose the questionnaire were based on a recent common local consumption report [20].

To assess physical activity level, the short version of the “International Physical Activity Questionnaire” (IPAQ) was employed. The IPAQ is an international questionnaire validated in 12 countries, including Brazil, and allows estimation of weekly time spent on physical activities of low, moderate, and high-intensity, in different contexts of daily life [21,22]. The short version of the IPAQ, used in the present study, is composed of seven open questions, and the

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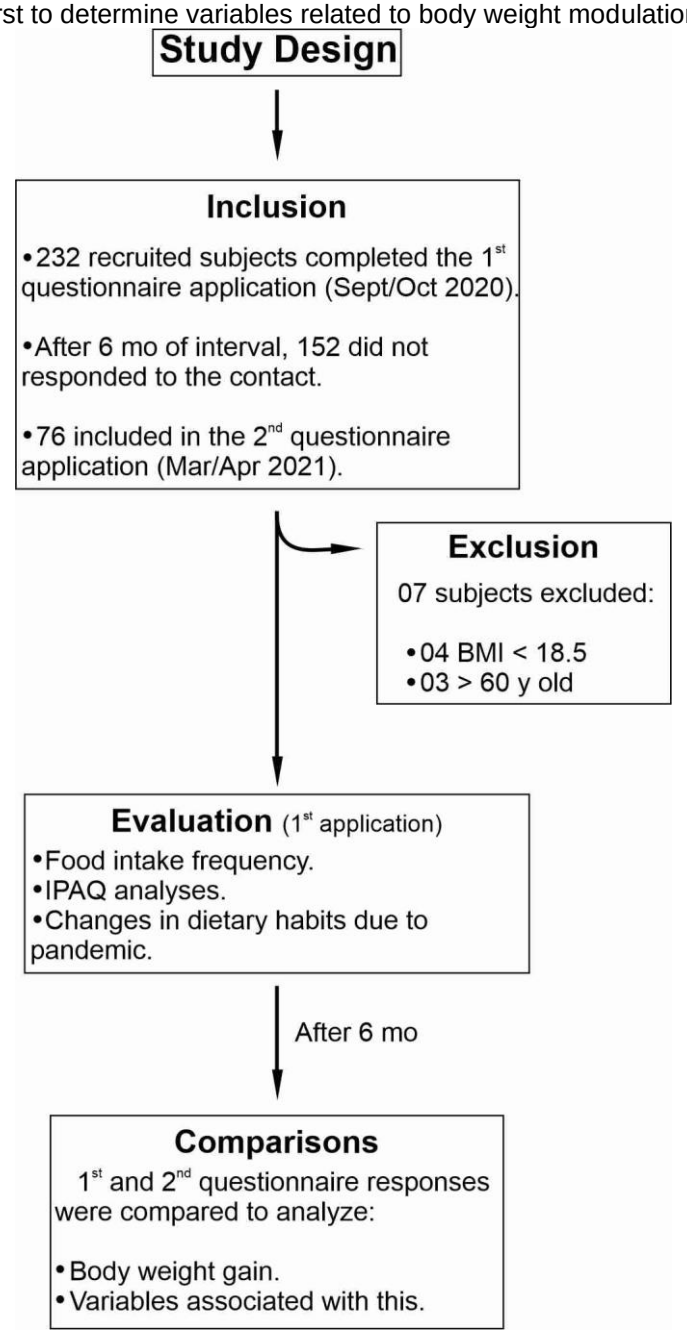
collected information can help estimate the time spent per week in different dimensions of physical activity, following metrics and calculations recommended by the IPAQ [21].

Figure 1. Representative flowchart of the study design. Participants were recruited to answer the first questionnaire survey. Six months later, the same individuals were invited to answer the questionnaire once again. The first survey (n=232) was performed to evaluate food intake frequency and habits, physical activities levels, and self-perceived changes in dietary behavior when compared with pre-pandemic behavior. The second survey (n=76) was compared with the first to determine variables related to body weight modulation.



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## 2.3 QUESTIONNAIRE

The questionnaire was self-filled online by a volunteer who had digitally consented; the survey was completed over approximately 10-15 min. The questions were divided into four main sections.

Section 1: Personal and anthropometric information such as age, height, weight, and other information regarding the inclusion/exclusion criteria.

Section 2: Food intake habits and frequency regarding the weekly consumption of different food categories. Questions included information regarding the weekly consumption of different types of leafy vegetables and non-leafy vegetables, legumes, fruits, oilseeds, carbohydrates, proteins, dairy, snacks, candies, and beverages. Based on the frequency reported, weekly consumption was scored as low (≤ 2 times a week), moderate (3-4 times a week), or high (≥ 5 times a week).

Section 3: Short version of the IPAQ. Individuals were classified into categories of low, moderate, and high levels of physical activity, as previously described [21].

Section 4: Altered eating behaviors during the COVID-19 pandemic when compared with those pre-pandemic, and the reasons for changes. In this section, the volunteers were asked if they had changed their eating patterns during the COVID-19 pandemic when compared with those pre-pandemic. The answer options were “yes” or “no”. If the answer was “yes,” they were asked regarding the reasons for changes. They could provide one or more options: i) ate more than pre-pandemic, ii) ate less than pre-pandemic, iii) ate at different times than pre-pandemic, iv) ate more fast-food (snacks, cookies, candies, pizza) than pre-pandemic; v) ordered more at home food deliveries than pre-pandemic; vi) started to eat more healthily (fruits, vegetables, legumes, grilled) than pre-pandemic; vii) started to access the refrigerator more during the day; viii) started eating a healthy, balanced diet. Finally, the volunteers were asked about routine changes due to possible emotional factors potentially interfering with food intake. They could report one or more options among the following: i) anxiety, ii) altered coexistence with people, iii) change in routine and work schedules, iv) difficulty in

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organizing and maintaining an eating routine at home, v) sadness, vi) loneliness, vii) difficulties accessing the market and bakery during the pandemic, viii) change in family income, ix) increased access to food at home and/or refrigerator, x) idle time

## 2.4 SAMPLE SIZE CALCULATION AND VALIDATION

The sample size was defined with an a priori analysis that determines the required sample size of a test for parameters of a logistic regression model associating a binary response variable Y, which denotes the occurrence or absence of an event, and an independent variable X. Typically, the acceptable levels for the studies consider the respective levels of 5% significance and 80% of power and consider the assumptions: independent variable with lognormal distribution, an odds ratio of 1.5, and probability of event occurrence under Ho = 0.2. The calculation results showed that approximately 95 individuals would be needed to reach a power of at least 80% for the explanatory variable, using the free software G*power (version 3.1.9.7).

As the questionnaire was created to collect habits related to consumption and its changes during the pandemic, semantic validation was performed to adjust for possible difficulties in understanding, verifying the relevance and order of the items in the survey. Cultural validation was also conducted (translated questions were used) for the IPAQ. Statistical validations were not performed, as it was not required for items to represent constructs or for a set of items to represent a concept.

## 2.5 STATISTICAL ANALYSIS

Descriptive analyses were performed for personal and anthropometric variables in the first and second rounds. Results are presented as mean with standard deviation in parentheses and number of participants in percentages (n [%]) and as mean ± standard deviation for continuous variables. BMI groups were analyzed using the Chi-square test for categorical variables related to food intake habits and frequency regarding the weekly consumption factors, level of physical

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activity, and altered eating behavior during the COVID-19 pandemic. A binary logistic regression analysis was performed to determine factors associated with weight gain in a multivariate model. First, a general characterization of the volunteers was presented. Tables present all significant variables according to BMI group and weight gain. Finally, a binary logistic regression was conducted for weight gain considering the sequential forward technique to identify the most important variable. This approach starts from the null model, which has no variables, and at each step of the procedure, the best new variable is added to the current model. All analyses were conducted using the IBM Statistical Package for Social Sciences (IBM SPSS), version 23.0 (SPSS Inc., Armonk, NY, USA).

## 3 RESULTS

After recruitment, we analyzed 232 responses in the present study. Among the volunteers, 1 reported type 2 diabetes (controlled with metformin), 11 reported hypertension (controlled with medication), 5 reported elevated cholesterol levels (controlled with medication), and 4 reported elevated cholesterol levels (controlled without medication). These volunteers were not excluded, given the observational nature of the study aimed to investigate modifications in the food frequency and habits affecting body weight due to the ongoing pandemic, despite pre-existing diseases (unless described in the exclusion criteria). In addition, we understood that the exclusion could induce bias during the analysis once the diseases were self-reported, and we could not confirm the severity and/or the individual's health status. Table 1 summarizes the general characterization of the volunteer groups who answered the questionnaire during the first and second surveys, separated by a six-month interval.

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Table 1. Individuals' characteristics in the first and second rounds of questionnaire application [presented as mean (standard deviation) and the number of participants (%)].

| | | First Round (n=232) | Second Round (n=76) |
|---|---|---|---|
| **Variable** | **Values** | **Total** | **Total** |
| Sex | Female | 150 (64.66) | 50 (65.79) |
| | Male | 80 (34.48) | 26 (34.21) |
| | Prefer not to answer | 2 (0.86) | - |
| Age | (years) | 31 ± 8,82 | 32 ± 8,92 |
| Height | (m) | 1.68 ± 0,10 | 1.68 ± 0.09 |
| Weight | (kg) | 74.44 ± 16.69 | 74.52 ± 15.65 |
| BMI | (kg/m2) | 26.31 ± 4,96 | 26.35 ± 5,10 |
| BMI group | Normal weight | 103 (44.40) | 34 (44.74) |
| | Overweight | 84 (36.21) | 25 (32.89) |
| | Obese | 45 (19.40) | 17 (22.37) |
| IPAQ | Low | 58 (25.00) | 19 (25.00) |
| | Moderate | 95 (40.95) | 33 (43.42) |
| | High | 79 (34.05) | 24 (31.58) |
| MET | Low | 47.22 ± 100.70 | 78.16 ± 112.43 |
| | Moderate | 1095.97 ± 576.19 | 1068.92 ± 506.38 |
| | High | 3422.62 ± 2240.07 | 3520.02 ± 2155.75 |

Data from the first and second questionnaire survey revealed that participants were aged 31 ± 8.82 and 32 ± 8,92 years, highlighted the predominance of young adults and females, and a BMI of 26.31 ± 4,96 and 26.35 ± 5,10, respectively. According to the BMI group, 44.40% and 44.74% were normal weight, 36.21% and 32.89% were overweight, and 19.40% and 22.37% exhibited some degree of obesity in the first and second surveys, respectively. The IPAQ classification revealed that 25% of individuals showed low levels of physical activity in both survey rounds (47.22 ± 100.70 and 78.16 ± 112.43 metabolic equivalents of task [MET] min/week), 40.95%, and 43.42% presented moderate levels (1095.97 ± 576.19 and 1068.92 ± 506.38 MET-min/week), and 34.05% and 31.58% (3422,62 ± 2240.07 and 3520,02 ± 2155.75 MET-min/week) showed high levels of physical activity, as reported in the first and second surveys, respectively. MET-min/week is a continuous variable that reflects energy expenditure during physical activity and is calculated from the IPAQ scoring [22].

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Despite the reduced data collected during the second survey, the percentages and mean of variables revealed similar values among variables such as sex, age, height, weight, BMI, IPAQ, and MET-min/week, decreasing the possibility of bias. The analyses were divided into two parts. In the first part of the study, we analyzed food intake frequency and habits, IPAQ, and self-perceived changes in food intake habits during the COVID-19 pandemic when compared with pre-pandemic habits. These analyses were performed for the first round of the questionnaire, including 232 responses. In the second part, we compared the first and second survey responses to evaluate variables related to body weight modulation. Accordingly, the responses of the second survey (n=76) were compared with those of the first survey, for the same volunteers, after a six-month interval.

For the first part of the study, Table 2 provides the frequency of perceived changes in eating habits and reasons for these changes during the COVID-19 pandemic when compared with pre-pandemic habits. The comparison was performed between BMI groups for significant variables after the Pearson Chi-square test. Overweight individuals reported a higher fast-food consumption, more snacks from the fridge, anxiety, and difficulty organizing a food routine when compared with the normal-weight group ($p < 0.1$).

Table 2. Change in food intake habits and reasons for the change between BMI group [presented as the number of participants (%)].

| | BMI Group | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Variables*** | **Normal weight** | | **Overweight** | | **Obese** | | ***Pearson Chi-square*** | ***P Value*** † | **Total** | |
| | ***N*** | ***%*** [a] | ***N*** | ***%*** [a] | ***N*** | ***%*** [a] | | | ***N*** | ***%*** [b] |
| ***more fast food consumption*** | | | | | | | | | | |
| No | 83 | 49.11 | 55 | 32.54 | 31 | 18.34 | 5.779 | 0.056 * | 169 | 72.84 |
| Yes | 20 | 31.75 | 29 | 46.03 | 14 | 22.22 | | | 63 | 27.16 |
| ***more snacks from fridge*** | | | | | | | | | | |
| No | 73 | 47.40 | 48 | 31.17 | 33 | 21.43 | 5.118 | 0.077 * | 154 | 66.38 |
| Yes | 30 | 38.46 | 36 | 46.15 | 12 | 15.38 | | | 78 | 33.62 |
| ***anxiety*** | | | | | | | | | | |
| No | 74 | 49.66 | 49 | 32.89 | 26 | 17.45 | 4.686 | 0.096 * | 149 | 64.22 |
| Yes | 29 | 34.94 | 35 | 42.17 | 19 | 22.89 | | | 83 | 35.78 |

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| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ***difficulty to organize a food routine*** | | | | | | | | | | |
| No | 84 | 48.28 | 57 | 32.76 | 33 | 18.97 | 4.712 | 0.095 * | 174 | 75.00 |
| Yes | 19 | 32.76 | 27 | 46.55 | 12 | 20.69 | | | 58 | 25.00 |
| **Total** | 103 | 44.40 | 84 | 36.21 | 45 | 19.40 | | | 232 | 100.00 |

No difference was observed between BMI groups in self-perceived changes during the COVID-19 pandemic in terms of consumption of healthier foods, increased or decreased food intake, changes in the timetable of eating, starting a healthy diet, ordering more food/fast-food deliveries, difficulty in shopping food products, increased food access, altered work routines, altered social routines, altered family income, loneliness, idle time, and sadness (Supplementary Table 1).

To complete the first part of the study, we compared the IPAQ and weekly food intake habits during the COVID-19 pandemic between the BMI group to determine significant variables after the Pearson Chi-square test. As shown in Table 3, overweight individuals and subjects with obesity presented a lower percentage of moderate and high levels of physical activity when compared with the normal-weight group ($p < 0.1$). In addition, among those who experienced high weekly fruit consumption, 52.21% were from the normal-weight group when compared with 32.91% of overweight subjects and 13.27% of individuals with obesity. The moderate and high consumption of ultra-processed beverages (such as soft drinks) was significantly higher in overweight individuals than in the other groups, followed by the increased consumption of non-ultra-processed snacks.

Table 3. IPAQ and weekly food intake frequency between BMI group [presented as the number of participants (%)].

| | **BMI Group** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Variables*** | **Normal weight** | | **Overweight** | | **Obese** | | ***Pearson Chi-square*** | ***P Value*** † | **Total** | |
| | ***N*** | ***%*** [a] | ***N*** | ***%*** [a] | ***N*** | ***%*** [a] | | | ***N*** | ***%*** [b] |
| ***IPAQ*** | | | | | | | | | | |
| Low | 17 | 29.31 | 28 | 48.28 | 13 | 22.41 | 8.423 | 0.077 * | 58 | 25.00 |
| Moderate | 45 | 47.37 | 30 | 31.58 | 20 | 21.05 | | | 95 | 40.95 |
| High | 41 | 51.90 | 26 | 32.91 | 12 | 15.19 | | | 79 | 34.05 |

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| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Fruits*** | | | | | | | | | | |
| Low | 17 | 34.00 | 17 | 34.00 | 16 | 32.00 | | | 50 | 21.55 |
| Moderate | 27 | 39.13 | 28 | 40.58 | 14 | 20.29 | 10.031 | 0.039 ** | 69 | 29.74 |
| High | 59 | 52.21 | 39 | 34.51 | 15 | 13.27 | | | 113 | 48.71 |
| ***Non-ultra snacks*** | | | | | | | | | | |
| Low | 101 | 46.12 | 74 | 33.79 | 44 | 20.09 | | | 219 | 94.40 |
| Moderate | 2 | 18.18 | 8 | 72.73 | 1 | 9.09 | 10.435 | 0.025 ** | 11 | 4.74 |
| High | 0 | 0.00 | 2 | 100.00 | 0 | 0.00 | | | 2 | 0.86 |
| ***Ultra beverage*** | | | | | | | | | | |
| Low | 85 | 48.85 | 54 | 31.03 | 35 | 20.11 | | | 174 | 75.00 |
| Moderate | 10 | 31.25 | 15 | 46.88 | 7 | 21.88 | 9.693 | 0.045 ** | 32 | 13.79 |
| High | 8 | 30.77 | 15 | 57.69 | 3 | 11.54 | | | 26 | 11.21 |
| **Total** | 103 | 44.40 | 84 | 36.21 | 45 | 19.40 | | | 232 | 100.00 |

[a]Values are expressed as percent in line; [b]Values are expressed as percent in column; † ** p < 0.05; * p < 0.1—significant using Pearson Chi-square for categorical data.

We observed non-significant differences between BMI groups and the weekly consumption of leafy and non-leafy vegetables, legumes, carbohydrates, proteins, dairy, ultra-processed snacks, flavoring, non-ultra-processed beverages, alcoholic drinks, candies, and oilseeds (Supplementary Table 2).

Next, we analyzed the second part of the study to examine the relationship between changes in body weight gain over time between the BMI groups and identify variables related to this phenomenon. As shown in Table 4, 16.22% of normal-weight individuals presented body weight gain during the 6-month interval when compared with 42.86% of overweight individuals and 50% of subjects with obesity, suggesting that the greater the initial BMI, the greater the changes in body weight gain. In addition, 94.44% of individuals who consumed higher levels of legumes on a weekly basis exhibited no body weight gain, suggesting that the consumption of natural and minimally processed foods may protect from body weight gain. All other variables analyzed showed no significant differences (Supplementary Table 3).

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Table 4. Variables associated with body weight gain in six months of the interval [presented as number of participants (%)].

| Variables | WEIGHT GAIN | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | No | | Yes | | | | Total | |
| | *N* | *%* [a] | *N* | *%*[a] | *Pearson Chi-square* | *P Value*† | *N* | *%*[b] |
| ***BMI Group*** | | | | | | | | |
| Normal weight | 31 | 83.78 | 6 | 16.22 | | | 37 | 48.68 |
| Overweight | 12 | 57.14 | 9 | 42.86 | 8.105 | 0.016 ** | 21 | 27.63 |
| Obese | 9 | 50.00 | 9 | 50.00 | | | 18 | 23.68 |
| ***Increased Legumes Intake*** | | | | | | | | |
| No | 35 | 60.34 | 23 | 39.66 | 7.393 | 0.008 ** | 58 | 76.32 |
| Yes | 17 | 94.44 | 1 | 5.56 | | | 18 | 23.68 |
| **Total** | 52 | 68.42 | 24 | 31.58 | | | 76 | 100.00 |

[a]Values are expressed as percent in line; [b]Values are expressed as percent in column; † ** p < 0.05; * p < 0.1—significant using Pearson Chi-square for categorical data

Finally, we performed a binary logistic regression analysis, and the results are presented in Table 5. Herein, we observed that BMI (overweight OR = 4.005, 95% confidence interval [CI]: 1.104–14.523, p < 0.05; obese OR = 7.009, 95% CI: 1.722–28.535, p < 0.05 compared to normal weight) and increased legume intake (OR = 0.069, 95% CI: 0.008–0.601, p < 0.05) were significantly associated with weight gain and loss, respectively. These findings suggested that individuals who were previously overweight or obese were 1.387- and 1.947-fold more likely to gain body mass, respectively, than those in the normal-weight group. Furthermore, the increased consumption of legumes reduced the estimated chances of body weight gain by 2.671-fold.

Table 5. Binary logistic regression for weight gain.

| *Parametes* | *Estimate* | *Standard Error* | *OR (95% CI)* | *P Valor*† |
|---|---|---|---|---|
| ***BMI Group*** | | | | |
| Normal weight (ref) | | | | |
| Overweight | 1.387 | 0.657 | 4.005 (1.104, 14.523) | 0.035 |
| Obese | 1.947 | 0.716 | 7.009 (1.722, 28.535) | 0.007 |
| ***Increased Legumes Intake*** | | | | |
| No (ref) | | | | |
| Yes | -2.671 | 1.103 | 0.069 (0.008, 0.601) | 0.015 |
| ***Constant*** | -1.334 | 0.459 | 0.263 | 0.004 |

[a]p < 0.05—significant using Binary Logistic Regression with WEIGHT GAIN as the dependent variable. This model was estimated with all variables.

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## 4 DISCUSSION

The new and sudden social restrictions imposed by the SARS-CoV-2 pandemic, in terms of isolation and distancing, undoubtedly impact several aspects of human life, which remain unpredictable. Changes in energy expenditure routines and food behavior have been previously documented in scientific reports from different parts of the world [23–25].

Our data showed that most overweight individuals experienced greater difficulty organizing a food routine and consumed more snacks and fast-foods than that detected pre-pandemic. These findings were similar to reports from other countries, highlighting the negative impacts of lockdown measures on lifestyle and triggering an increased consumption of comfort foods and snacks [26–29]. Although these studies evaluated the population in general, we stratified the analyses according to BMI, allowing a better understanding of the dietary behavior of individuals with different nutritional statuses.

In the present study, overweight individuals also experienced more anxiety during the pandemic than that pre-pandemic when compared with the normal weight. These data emphasize how negative emotional experiences directly influence food behavior, worsening body weight control [30–32]. Individuals with anxiety symptoms tend to develop emotional eating disorders, which are also associated with the consumption of hypercaloric snacks, mainly high-sugar and high-fat food products [32,33]. Di Renzo et al. have reported that higher BMIs and lower age were associated with increased junk food consumption during quarantine periods in Italy [34]. In addition, self-reported cross-sectional analyses have revealed that 17% of patients with obesity showed increased snack intake followed by body weight gain during COVID-19 lockdown [35]. Our data indicate that if anxiety persists over time, overweight individuals could develop emotional eating disorders, predisposing these individuals to diet-induced obesity.

Following the imposition of restrictive measures to free movement, one consequence was the increased risk of sedentarism, despite other general routine alterations [28]. Physical activity is one of the most effective non-pharmacological interventions to prevent body weight gain and is even used as

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a strategy for weight loss [36,37]. Herein, we observed that only 25% of the individuals reported low levels of physical activity both in the first and second questionnaire surveys, representing less than 150-300 min/week of moderate exercise and/or 75-150 min/week of vigorous physical activity, as recommended for adults [37]. These data differ from studies showing that approximately 30% and 38% of Spaniards and Italians, respectively, lacked physical activity during the lockdown when compared with almost 60% of French and Portuguese individuals [34,38–40].

However, on stratifying IPAQ results according to BMI, we observed that normal-weight individuals displayed significantly higher physical activity levels per week than overweight individuals and subjects with obesity, reinforcing the importance of evaluating individuals by nutritional status. Herein, we found that only 15.19% of the individuals with obesity practiced high levels of physical activity during the pandemic, followed by 32.91% of the overweight individuals and 51.90% of the normal-weight group. Recent studies have focused on the need to develop public policies to stimulate exercise practice and improve the health quality of life, especially in vulnerable populations [41–43]. Collectively, our findings suggest that reduced physical activity levels during the pandemic are more pronounced in individuals exhibiting elevated BMI, corroborating the relevance of physical activity in combination with a well-balanced diet to prevent metabolic diseases.

One of the mechanisms related to body weight gain is a positive energy balance, i.e., calories ingested over a period exceed the energy expenditure during the same period [44]. It is also important to consider food choices. The consumption of hypercaloric foods has been facilitated over the years, especially since the 1980s, given the growing need for fast meals, increased durability, and lower costs [45–47]. Although food processing emerged to assist contemporary lifestyles, ultra-processed foods are highly energy-dense and rich in saturated fatty acids and sugars [48].

In the present study, we demonstrated that normal-weight individuals reported higher consumption of fruits (≥ five times a week) when compared with

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overweight or obese individuals. Conversely, nearly 50-60% of individuals with increased BMIs reported the intake of ultra-processed beverages, such as industrialized soft drinks, energy drinks, and cocoa drinks, 3-7 times weekly. The consumption of ultra-processed products grew by 43.7% between 2000 and 2013, resulting in a 30.6% growth in sales in Brazil [49]. The excessive consumption of ultra-processed products increases the risk of developing obesity by 26%, metabolic syndrome by 79%, dyslipidemia by 102%, and cardiovascular risk by 29-34% [50,51]. Herein, we evaluated consumption during a regular week. It is well-known that a diet rich in ultra-processed foods, if consumed for at least two to three weeks in association with a sedentary lifestyle, can lead to weight gain and metabolic alterations in humans [47]. Our findings indicate that consuming more natural and minimally processed food during quarantine could be related to body weight maintenance, whereas the consumption of ultra-processed products was associated with increased BMIs.

Compared over time, approximately 40-50% of the individuals from the overweight and obese groups showed increased body weight after the 6-month interval. These data need to be highlighted, as metabolically obese individuals can present a hyperglycemic and inflammatory state that could aggravate the prognosis after SARS-CoV-2 infection, given the cytokine storm followed by lung damage [52–55]. The excess white adipose tissue could serve as a reservoir for coronaviruses, reinforcing obesity as a risk factor for COVID-19 and the importance of aggressive measures for obesity management [56,57].

Finally, the logistic regression results revealed that after six months of social restriction during the COVID-19 pandemic, BMI was the main variable related to body weight gain in our sample of Brazilian individuals. The data indicate that as BMI increases, there is a higher probability of body weight gain due to social isolation, reinforcing the possibility of aggravating obesity in the investigated population. Our findings corroborate the results of Costa et al., who showed that 19.7 % of individuals gained at least 2 kg over 6 months at the beginning of the pandemic [58]. Conversely, we showed that individuals who increased legume consumption, including beans, lentils, peanuts, and peas, over

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the 6-month period exhibited a 2.5-fold lower possibility of increased body weight. These data indicate that specific types of foods could determine the energy homeostasis balance, as suggested by Mazzolani et al., who observed that normal-weight Brazilian women maintained a healthier diet during lockdown than overweight and obese women [59]. It is crucial to emphasize that energy homeostasis is complex and depends on multiple variables, including genetics and environmental factors.

This study had some limitations. The information collected from the questionnaire was self-reported, relying on the possibility of overestimation and underestimation. Moreover, between the first and second surveys, we experienced a considerable number of dropouts. We did not perform analyze the representativeness of the study population. However, the distribution of our sample according to BMI followed the most recent data for the Brazilian population. This study, although limited, contributes to the existing literature in terms of variables related to body weight gain during the COVID-19 pandemic, especially BMI.

## 5 CONCLUSIONS

In summary, our data indicate that in a group of Brazilians, individuals with higher BMIs experienced greater difficulty organizing their food routine during the pandemic, triggering increased food intake and body weight gain. In addition, normal-weight individuals displayed a higher level of physical activity even during the pandemic period. After a six-month interval, almost 50% of both overweight individuals and subjects with obesity had increased body weight, indicating that social restrictions imposed by the pandemic negatively influenced the ongoing obesity epidemic. The food frequency questionnaire revealed that the consumption of natural and/or minimally processed foods might be related to the prevention of body weight gain. Collectively, our data indicate that the type, amount, and frequency of food intake, in association with physical activities, could help control energy imbalance in individuals with elevated BMIs. Logistic regression analyses revealed that individuals with obesity were 2-fold more likely

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to gain weight during the pandemic, reinforcing the need for proactive and personalized measures to treat obesity.

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## CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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## REFERENCES

World Health Organization. Obesity: preventing and managing the global epidemic. Report of a WHO consultation. *World Health Organ Tech Rep Ser* **2000**, *894*, i-xii, 1-253.

González-Muniesa, P.; Mártinez-González, M.A.; Hu, F.B.; Després, J.P.; Matsuzawa, Y.; Loos, R.J.F.; Moreno, L.A.; Bray, G.A.; Martinez, J.A. Obesity. *Nat. Rev. Dis. Prim.* **2017**, *3*, doi:10.1038/nrdp.2017.34.

Font-Burgada, J.; Sun, B.; Karin, M. Obesity and Cancer: The Oil that Feeds the Flame. *Cell Metab.* **2016**, *23*, 48–62, doi:10.1016/j.cmet.2015.12.015.

Ackerman, S.E.; Blackburn, O.A.; Marchildon, F.; Cohen, P. Insights into the Link Between Obesity and Cancer. *Curr. Obes. Rep.* **2017**, *6*, 195–203, doi:10.1007/s13679-017-0263-x.

Piché, M.E.; Tchernof, A.; Després, J.P. Obesity Phenotypes, Diabetes, and Cardiovascular Diseases. *Circ. Res.* **2020**, 1477–1500, doi:10.1161/CIRCRESAHA.120.316101.

Dobbs, R.; Sawers, C.; Thompson, F.; Manyika, J.; Woetzel, J.; Child, P.; McKenna, S.; Spatharou, A. Overcoming obesity: An initial economic analysis Discussion paper. *McKinsey Glob. Inst.* **2014**, 1–71.

World Health Organization Obesity and overweight Available online: https://www.who.int/en/news-room/fact-sheets/detai (accessed on Jun 23, 2021).

Nilson, E.A.F.; Santin Andrade, R. da C.; de Brito, D.A.; de Oliveira, M.L. Costs attributable to obesity, hypertension, and diabetes in the Unified Health System, Brazil, 2018. *Rev. Panam. Salud Publica/Pan Am. J. Public Heal.* **2020**, *44*, 1–7, doi:10.26633/RPSP.2020.32.

Brasil. Ministério da Saúde. Vigitel Brasil 2019 [Internet]. Vigitel Brasil 2019 : vigilância de fatores de risco e proteção para doenças crônicas por inquérito telefônico : estimativas sobre frequência e distribuição sociodemográfica de fatores de risco e proteção para doenças crônicas nas capitais dos 26 estados . **2020**. 139 p. Available from: https://www.saude.gov.br/images/pdf/2020/April/27/vigitel-brasil-2019-vigilancia-fatores-risco.pdf.

Phelan, A.L.; Katz, R.; Gostin, L.O. The Novel Coronavirus Originating in Wuhan, China: Challenges for Global Health Governance. *JAMA - J. Am. Med. Assoc.* **2020**, *323*, 709–710, doi:10.1001/jama.2020.1097.

Dong, E.; Du, H.; Gardner, L. An interactive web-based dashboard to track COVID-19 in real time. *Lancet Infect. Dis.* **2020**, *20*, 533–534, doi:10.1016/S1473-3099(20)30120-1.

EUROPUB JOURNAL OF HEALTH RESEARCH
Europub European Publications
ISSN: 2795-4498

Clemmensen, C.; Petersen, M.B.; Sørensen, T.I.A. Will the COVID-19 pandemic worsen the obesity epidemic? *Nat. Rev. Endocrinol.* **2020**, *16*, 469–470, doi:10.1038/s41574-020-0387-z.

Robb, C.E.; de Jager, C.A.; Ahmadi-Abhari, S.; Giannakopoulou, P.; Udeh-Momoh, C.; McKeand, J.; Price, G.; Car, J.; Majeed, A.; Ward, H.; et al. Associations of Social Isolation with Anxiety and Depression During the Early COVID-19 Pandemic: A Survey of Older Adults in London, UK. *Front. Psychiatry* **2020**, *11*, 1–12, doi:10.3389/fpsyt.2020.591120.

Kaufman-Shriqui, V.; Navarro, D.A.; Raz, O.; Boaz, M. Dietary changes and anxiety during the coronavirus pandemic: a multinational survey. *Eur. J. Clin. Nutr.* **2021**, doi:10.1038/s41430-021-00897-3.

Volz, L.J.; Ahrens, R.A. A Three-Meal-a-Day Dietary Pattern Versus Ad Libitum Food Intake in the Albino Rat. *J. Nutr.* **1978**, *108*, 1033–1038, doi:10.1093/jn/108.6.1033.

Razolli, D.S.; Moura-Assis, A.; Bombassaro, B.; Velloso, L.A. Hypothalamic neuronal cellular and subcellular abnormalities in experimental obesity. *Int. J. Obes.* **2019**, *43*, 2361–2369, doi:10.1038/s41366-019-0451-8.

Thaler, J.P.; Yi, C.-X.; Schur, E.A.; Guyenet, S.J.; Hwang, B.H.; Dietrich, M.O.; Zhao, X.; Sarruf, D.A.; Izgur, V.; Maravilla, K.R.; et al. Obesity is associated with hypothalamic injury in rodents and humans. *J. Clin. Invest.* **2012**, *122*, 153–162, doi:10.1172/JCI59660.

de Castro, M.A.; Marchioni, D.M.L.; Fisberg, L.M. Manual de Críticas de Inquéritos alimentares. Edition updated by LOPES, L. do V. C.; FONTANELLI, M. M. Viçosa, MG. **2013**. 25 p.

Filho, A. A. B.; Barros, M. B. A; Fisberg, R. M.; Domene, S. M. M. Álvares; Zangirolani, L. T. O.; de Oliveira; J. M.; Porto, A. M. C. G.; Luz, V.G. Inquérito de nutrição no município de Campinas - Isacamp-nutri. **2014**, 1–9. Available in https://www.fcm.unicamp.br/fcm/sites/default/files/2016/page/manual_isacamp_nutri_2014.pdf

Instituto Brasileiro de Geografia e Estatística - IBGE Pesquisa de Orçamentos Familiares 2017-2018: análise de consumo alimentar pessoal no Brasil; **2020**; ISBN 9788524041389.

Craig, C.L.; Marshall, A.L.; Sjöström, M.; Bauman, A.E.; Booth, M.L.; Ainsworth, B.E.; Pratt, M.; Ekelund, U.; Yngve, A.; Sallis, J.F.; et al. International physical activity questionnaire: 12-Country reliability and validity. *Med. Sci. Sports Exerc.* **2003**, *35*, 1381–1395, doi:10.1249/01.MSS.0000078924.61453.FB.

IPAQ Research Committee Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ)-Short and Long Forms.

EUROPUB JOURNAL OF HEALTH RESEARCH
Europub European Publications
ISSN: 2795-4498

Version 2.0. April **2004** [accessed in 2021 September 20] Available from: https://www.physio-pedia.com/images/c/c7/Quidelines_for_interpreting_the_IPAQ.pdf

Seal, A.; Schaffner, A.; Phelan, S.; Brunner-Gaydos, H.; Tseng, M.; Keadle, S.; Alber, J.; Kiteck, I.; Hagobian, T. COVID-19 pandemic and stay-at-home mandates promote weight gain in US adults. *Obesity (Silver Spring).* **2021**, 0–3, doi:10.1002/oby.23293.

Catucci, A.; Scognamiglio, U.; Rossi, L. Lifestyle Changes Related to Eating Habits, Physical Activity, and Weight Status During COVID-19 Quarantine in Italy and Some European Countries. *Front. Nutr.* **2021**, *8*, 1–6, doi:10.3389/fnut.2021.718877.

Cheikh Ismail, L.; Hashim, M.; Mohamad, M.N.; Hassan, H.; Ajab, A.; Stojanovska, L.; Jarrar, A.H.; Hasan, H.; Abu Jamous, D.O.; Saleh, S.T.; et al. Dietary Habits and Lifestyle During Coronavirus Pandemic Lockdown: Experience From Lebanon. *Front. Nutr.* **2021**, *8*, 1–11, doi:10.3389/fnut.2021.730425.

Husain, W.; Ashkanani, F. Does COVID-19 change dietary habits and lifestyle behaviours in Kuwait: A community-based cross-sectional study. *Environ. Health Prev. Med.* **2020**, *25*, 1–13, doi:10.1186/s12199-020-00901-5.

Scarmozzino, F.; Visioli, F. Covid-19 and the subsequent lockdown modified dietary habits of almost half the population in an Italian sample. *Foods* **2020**, *9*, doi:10.3390/foods9050675.

Ammar, A.; Brach, M.; Trabelsi, K.; Chtourou, H.; Boukhris, O.; Masmoudi, L.; Bouaziz, B.; Bentlage, E.; How, D.; Ahmed, M.; et al. Effects of COVID-19 Home Confinement on Eating Behaviour and Physical Activity : Results of the. *Nutrients* **2020**, *12*, 13.

Reyes-Olavarría, D.; Latorre-Román, P.Á.; Guzmán-Guzmán, I.P.; Jerez-Mayorga, D.; Caamaño-Navarrete, F.; Delgado-Floody, P. Positive and negative changes in food habits, physical activity patterns, and weight status during covid-19 confinement: Associated factors in the chilean population. *Int. J. Environ. Res. Public Health* **2020**, *17*, 1–14, doi:10.3390/ijerph17155431.

Tomiyama, A.J. Stress and Obesity. *Annu. Rev. Psychol.* **2019**, *70*, 703–718, doi:10.1146/annurev-psych-010418-102936.

Jacques, A.; Chaaya, N.; Beecher, K.; Ali, S.A.; Belmer, A.; Bartlett, S. The impact of sugar consumption on stress driven, emotional and addictive behaviors. *Neurosci. Biobehav. Rev.* **2019**, *103*, 178–199, doi:10.1016/j.neubiorev.2019.05.021.

Pellegrini, M.; Ponzo, V.; Rosato, R.; Scumaci, E.; Goitre, I.; Benso, A.; Belcastro,

EUROPUB JOURNAL OF HEALTH RESEARCH
Europub European Publications
ISSN: 2795-4498

S.; Crespi, C.; De Michieli, F.; Ghigo, E.; et al. Changes in weight and nutritional habits in adults with obesity during the “lockdown” period caused by the COVID-19 virus emergency. *Nutrients* **2020**, *12*, 1–11, doi:10.3390/nu12072016.

Camilleri, G.M.; Méjean, C.; Kesse-Guyot, E.; Andreeva, V.A.; Bellisle, F.; Hercberg, S.; Péneau, S. The associations between emotional eating and consumption of energy-dense snack foods are modified by sex and depressive symptomatology. *J. Nutr.* **2014**, *144*, 1264–1273, doi:10.3945/jn.114.193177.

Di Renzo, L.; Gualtieri, P.; Pivari, F.; Soldati, L.; Attinà, A.; Cinelli, G.; Cinelli, G.; Leggeri, C.; Caparello, G.; Barrea, L.; et al. Eating habits and lifestyle changes during COVID-19 lockdown: An Italian survey. *J. Transl. Med.* **2020**, *18*, 1–15, doi:10.1186/s12967-020-02399-5.

de Luis Román, D.A.; Izaola, O.; Primo Martín, D.; Gómez Hoyos, E.; Torres Torres, B.; López Gómez, J.J. Effect of lockdown for COVID-19 on self-reported body weight gain in a sample of obese patients. *Nutr. Hosp.* **2020**, doi:10.20960/nh.03307.

Jakicic, John M; Powell, Kenneth E; Campbell, Wayne W; Dipietro, Loretta; Pate, Rossell R; Pescatello, Linda S; Collins, Katherine A; Bloodgood, Bonny; Piercy, K.L. Physical Activity and the Prevention of Weight Gain in Adults: A Systematic Review. *Med. Sci. Sport. Exerc.* **2019**, *51*, 1262–1269, doi:10.1249/MSS.0000000000001938.

Okely, A.D.; Kontsevaya, A.; Ng, J.; Abdeta, C. WHO guidelines on physical activity and sedentary behavior. *Sport. Med. Heal. Sci.* **2021**, *3*, 115–118, doi:10.1016/j.smhs.2021.05.001.

Sánchez-Sánchez, E.; Ramírez-Vargas, G.; Avellaneda-López, Y.; Orellana-Pecino, J.I.; García-Marín, E.; Díaz-Jimenez, J. Eating habits and physical activity of the spanish population during the covid-19 pandemic period. *Nutrients* **2020**, *12*, 1–12, doi:10.3390/nu12092826.

Publique, S. CoviPrev : une enquête pour suivre l’évolution des comportements et de la santé mentale pendant l’épidémie de COVID-19. Available online at: https://www.santepubliquefrance.fr/etudes-et-enquetes/covid-19-une-enquete-pour-suivre-l-evolution-des-comportements-et-de-la-sante-mentale-pendant-l-epidemie **2021** (accessed 21 Set, 2021).

Direção-Geral da Saúde REACT-COVID - Inquérito sobre alimentação e atividade física em contexto de contenção social. **2020**, 1–15. Available online at: https://www.dgs.pt/programa-nacional-para-a-promocao-da-atvidade-fisica/ficheiros-externos-pnpaf/rel_resultados-survey-covid-19-pdf.aspx (accessed 21 Set, 2021).

da Rocha, A.Q.; Lobo, P.C.B.; Pimentel, G.D. Muscle Function Loss and Gain of Body Weight during the COVID-19 Pandemic in Elderly Women: Effects of One

EUROPUB JOURNAL OF HEALTH RESEARCH
Europub European Publications
ISSN: 2795-4498

Year of Lockdown. *J. Nutr. Heal. Aging* **2021**, *25*, 1028–1029, doi:10.1007/s12603-021-1663-x.

Ruíz-Roso, M.B.; De Carvalho Padilha, P.; Matilla-Escalante, D.C.; Brun, P.; Ulloa, N.; Acevedo-Correa, D.; Ferreira Peres, W.A.; Martorell, M.; Bousquet Carrilho, T.R.; De Oliveira Cardoso, L.; et al. Changes of Physical Activity and Ultra-Processed Food Consumption in Adolescents from Di ff erent. *Nutrients* **2020**, *12*, 1–13.

Ruiz-Roso, M.B.; Knott-Torcal, C.; Matilla-Escalante, D.C.; Garcimartín, A.; Sampedro-Nuñez, M.A.; Dávalos, A.; Marazuela, M. Covid-19 lockdown and changes of the dietary pattern and physical activity habits in a cohort of patients with type 2 diabetes mellitus. *Nutrients* **2020**, *12*, 1–16, doi:10.3390/nu12082327.

Sadaf Farooqi, I.; O'Rahilly, S. Leptin: A pivotal regulator of human energy homeostasis. *Am. J. Clin. Nutr.* **2009**, *89*, 980–984, doi:10.3945/ajcn.2008.26788C.

Monteiro, C.A.; Cannon, G.; Levy, R.B.; Moubarac, J.-C.; Louzada, M.L.; Rauber, F.; Khandpur, N.; Cediel, G.; Neri, D.; Martinez-Steele, E.; et al. Ultra-processed foods: what they are and how to identify them. *Public Health Nutr.* **2019**, *22*, 936–941, doi:10.1017/S1368980018003762.

Swinburn, B.A.; Kraak, V.I.; Allender, S.; Atkins, V.J.; Baker, P.I.; Bogard, J.R.; Brinsden, H.; Calvillo, A.; De Schutter, O.; Devarajan, R.; et al. The Global Syndemic of Obesity, Undernutrition, and Climate Change: The Lancet Commission report. *Lancet* **2019**, *393*, 791–846, doi:10.1016/S0140-6736(18)32822-8.

Hall, K.D.; Ayuketah, A.; Brychta, R.; Cai, H.; Cassimatis, T.; Chen, K.Y.; Chung, S.T.; Costa, E.; Courville, A.; Darcey, V.; et al. Ultra-Processed Diets Cause Excess Calorie Intake and Weight Gain: An Inpatient Randomized Controlled Trial of Ad Libitum Food Intake. *Cell Metab.* **2019**, *30*, 67-77.e3, doi:10.1016/j.cmet.2019.05.008.

Monteiro, C.A.; Cannon, G.; Moubarac, J.C.; Levy, R.B.; Louzada, M.L.C.; Jaime, P.C. The UN Decade of Nutrition, the NOVA food classification and the trouble with ultra-processing. *Public Health Nutr.* **2018**, *21*, 5–17, doi:10.1017/S1368980017000234.

Monteiro, C.A.; Moubarac, J.C.; Cannon, G.; Ng, S.W.; Popkin, B. Ultra-processed products are becoming dominant in the global food system. *Obes. Rev.* **2013**, *14*, 21–28, doi:10.1111/obr.12107.

Pagliai, G.; Dinu, M.; Madarena, M.P.; Bonaccio, M.; Iacoviello, L.; Sofi, F. Consumption of ultra-processed foods and health status: A systematic review and meta-Analysis. *Br. J. Nutr.* **2021**, *125*, 308–318, doi:10.1017/S0007114520002688.

EUROPUB JOURNAL OF HEALTH RESEARCH
Europub European Publications
ISSN: 2795-4498

Askari, M.; Heshmati, J.; Shahinfar, H.; Tripathi, N.; Daneshzad, E. Ultra-processed food and the risk of overweight and obesity: a systematic review and meta-analysis of observational studies. *Int. J. Obes.* **2020**, *44*, 2080–2091, doi:10.1038/s41366-020-00650-z.

Stefan, N.; Birkenfeld, A.L.; Schulze, M.B. Global pandemics interconnected — obesity, impaired metabolic health and COVID-19. *Nat. Rev. Endocrinol.* **2021**, *17*, 135–149, doi:10.1038/s41574-020-00462-1.

Michalakis, K.; Ilias, I. SARS-CoV-2 infection and obesity: Common inflammatory and metabolic aspects. *Diabetes Metab. Syndr. Clin. Res. Rev.* **2020**, *14*, 469–471, doi:10.1016/j.dsx.2020.04.033.

Williamson, E.J.; Walker, A.J.; Bhaskaran, K.; Bacon, S.; Bates, C.; Morton, C.E.; Curtis, H.J.; Mehrkar, A.; Evans, D.; Inglesby, P.; et al. Factors associated with COVID-19-related death using OpenSAFELY. *Nature* **2020**, *584*, 430–436, doi:10.1038/s41586-020-2521-4.

Huang, C.; Wang, Y.; Li, X.; Ren, L.; Zhao, J.; Hu, Y.; Zhang, L.; Fan, G.; Xu, J.; Gu, X.; et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet* **2020**, *395*, 497–506, doi:10.1016/S0140-6736(20)30183-5.

Cheng, H.; Wang, Y.; Wang, G.Q. Organ-protective effect of angiotensin-converting enzyme 2 and its effect on the prognosis of COVID-19. *J. Med. Virol.* **2020**, *92*, 726–730, doi:10.1002/jmv.25785.

Stiefel, P.; Vallejo-Vaz, A.J.; García Morillo, S.; Villar, J. Role of the renin-angiotensin system and aldosterone on cardiometabolic syndrome. *Int. J. Hypertens.* **2011**, *2011*, doi:10.4061/2011/685238.

Costa, C.D.S.; Steele, E.M.; Leite, M.A.; Rauber, F.; Levy, R.B.; Monteiro, C.A. Body weight changes in the NutriNet Brasil cohort during the covid-19 pandemic. *Rev. Saude Publica* **2021**, *55*, 01, doi:10.11606/s1518-8787.2021055003457.

Mazzolani, B.C.; Smaira, F.I.; Esteves, G.P.; Santo André, H.C.; Amarante, M.C.; Castanho, D.; Campos, K.; Benatti, F.B.; Pinto, A.J.; Roschel, H.; et al. Influence of Body Mass Index on Eating Habits and Food Choice Determinants Among Brazilian Women During the COVID-19 Pandemic. *Front. Nutr.* **2021**, *8*, 1–10, doi:10.3389/fnut.2021.664240.