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Applied nutritional investigation

Emotional eating, binge eating, physical inactivity, and vespertine chronotype are negative predictors of dietary practices during COVID-19 social isolation: A cross-sectional study



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ABSTRACT

Objectives: Coronavirus disease 2019 (COVID-19) emerged and rapidly spread worldwide. Several countries have imposed lockdown and isolation in attempt to mitigate viral spread. However, social isolation has a negative effect on psychological aspects, increasing stress, fear, anxiety, anger and emotional disturbance, as well as affecting sleep pattern and the practice of physical activity. Negative emotions and lifestyle changes trigger overeating, consequently affecting dietary practices. The aim of this study was to verify the prevalence of lifestyle factors (i.e., sleep time/quality and practice of physical exercise), eating behavior dimensions, chronotype, and association with dietary practices (planning, domestic organization, food choice, ways of eating) in home confinement during the COVID-19 pandemic in São Paulo, Brazil.

Methods: This cross-sectional study was conducted between April 27 and May 25, 2020. An anonymous online questionnaire (Microsoft Forms) was used for data collection by the snowball method. We verified dietary practices (outcome), eating behavior, physical exercise practice, sleep quality and duration, and chronotype (exposure variables). Sex, age, educational and social status were assessed as covariates and confounders. We evaluated 724 adults (585 women and 139 men). Mean age was 32.6 y (± 11.3) for women and 33.5 y (± 10.5) for men.

Results: Emotional eating (EE) and binge eating (BE) were positively correlated ($r = 0.66$; $P < 0.001$). Dietary practices were negatively correlated with BE ($r = -0.41$; $P < 0.001$), EE ($r = -0.33$; $P < 0.001$) and body mass index ($r = -0.24$; $P < 0.001$). Linear regression demonstrated that EE ($\beta = -0.1351$; $t = -2.841$; $P = 0.005$; $\eta_p^2 = 0.013$), BE ($\beta = -0.2580$; $t = -5.612$; $P < 0.001$; $\eta_p^2 = 0.050$), no practice of physical exercise at home ($\beta = -0.4271$; $t = -5.933$; $P < 0.001$; $\eta_p^2 = 0.055$), being vespertine ($\beta = -0.3435$; $t = 2.076$; $P = 0.038$; $\eta_p^2 = 0.019$), and age ($\beta = -0.082$; $t = -2.210$; $P = 0.027$; $\eta_p^2 = 0.008$) are negative predictors of dietary practices. Finally, cognitive restraint ($\beta = 0.1407$; $t = 3.858$; $P < 0.001$; $\eta_p^2 = 0.024$), better sleep quality ($\beta = 0.1768$; $t = 2.506$; $P = 0.012$; $\eta_p^2 = 0.010$), receiving 4–10 wages per month (according to a minimum wage in Brazil that corresponds to US \$ 183.01) ($\beta = 0.2568$; $t = 2.573$; $P = 0.10$; $\eta_p^2 = 0.027$) and 10 – 20 wages per month ($\beta = 0.4490$; $t = 3.726$; $P < 0.001$; $\eta_p^2 = 0.027$) are positive predictors of dietary practices.

Conclusion: Eating behavior, physical exercise, sleep, and social factors can be important predictors for dietary practices during COVID-19 social confinement. Longitudinal studies in Brazil are needed to confirm these findings.

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Introduction

Coronavirus disease 2019 (COVID-19) caused by acute respiratory syndrome coronavirus 2 (SARS-CoV-2) emerged in December 2019 in Wuhan, China [1]. The highly transmissible virus and the interaction between people from different countries, driven by globalization and many international flights, increased the rapid spread of SARS-CoV-2 worldwide [2]. In Brazil, COVID-19 was recognized as a national public health emergency on February 3, 2020 [3]. The World Health Organization (WHO) declared the new coronavirus outbreak to be a pandemic on March 11, 2020 [4]. To counteract the new coronavirus spread due to vaccine absence, China adopted rigorous and comprehensive public health actions, including blockages in the public and private sectors, underpinning social isolation and quarantine [2,5]. After social interventions were applied, the daily number of new China cases decreased [2]. Following these practices, several countries imposed lockdown and isolation at different magnitudes to mitigate viral spread [5]. Brazil was one of the most affected countries by COVID-19; however, due to political polarization, social distancing and isolation strategies were partially imposed. Guidance on mask use, reducing crowds, and closing of non-essential services was proposed, despite the population's resistance. Additionally, Jair Bolsonaro, President of Brazil, together with the last minister of health, minimized the severity of the disease, hindered data provision, and encouraged treatment strategies for COVID-19 that were not based on scientific evidence (i.e., chloroquine, ivermectin, and zinc supplementation). Brazil is composed of many vulnerable communities and characterized by an emerging economy, besides having a relatively weak social protection system, which makes the battle against the pandemic overly challenging [6,7].

Home confinement negatively affects daily lives, compromising social, economic, and psychological aspects [8,9]. The COVID-19 pandemic suddenly transformed the world population's lifestyle and imposed new challenges to maintain physical activity, sleep habits, stress management, and adequate healthy food intake [10,11]. According to Tan et al. [12], social isolation limits access to fresh food, mainly due to difficulties in transportation, distribution, and delivery, leading to greater intake of ultraprocessed foods. Conditions inherent to home confinement, such as stress, fear, anxiety, anger, and emotional disturbance, can also drive changes in eating habits [10]. Stress is a trigger for increased food intake, especially "comfort foods" [13], and it can promote changes in total sleep time and sleep architecture, activating reward mechanisms that increase the odds of eating without control [13,14].

Physical inactivity, short sleep duration, or low sleep quality can also increase stress and food intake, inducing a vicious and worrying cycle of weight gain [11,15]. Disparities may also be associated with socioeconomic, educational, and environmental disadvantages, contemplating a scenario of food insecurity which contributes to increased consumption of more accessible unhealthy foods [16,17].

The scientific community has speculated on the health effects of these lifestyle changes, as a result of social isolation. Initially, researchers showed an evident interest in discussing nutrition, food intake, and obesity, mainly because the latter is considered a complicating factor in COVID-19 [12]. Perspectives, comments, and editorials were published during the pandemic, opening further discussions on the relationship between dietary practices, stress, fear, anxiety, and social isolation [10]. A recent study showed that Spanish population's home confinement promoted weight gain and worsened sleep quality [18]. Other authors have observed low craving control and increased intake of high energy-dense sweet and savory foods during COVID-19 social isolation [19]. However, the association of dietary practices with other potential influencing

factors has been little explored in COVID-19 home confinement context, especially in countries such as Brazil, a multicultural country with profound social inequalities.

The present study aimed to verify the prevalence of lifestyle factors (i.e., sleep quality, sleep duration, and practice of physical exercise), eating behavior dimensions, and chronotype, exploring associations among dietary practices in home confinement during the COVID-19 pandemic in São Paulo, Brazil.

Methods

Study design and participants

This cross-sectional study was conducted between April 27 and May 25, 2020, when the State of São Paulo/Brazil had an average isolation rate of 50.8% (46–59%). This average was calculated using daily values from April 27 to May 25, a period during which, in São Paulo, social isolation reached its highest rates. Social isolation indexes are published daily by the Information and Intelligent Monitoring System of the State of São Paulo and the Institute for Technological Research's technical team. Data is made available by the telecommunications service providers through a Big Data platform managed by the Brazilian Association of Telecommunications Resources. The isolation index is based on the location obtained by cell phone antennas. Between 10 pm and 2 am, its geographic location is considered a reference point. A cell phone that has departed this reference point by approximately 200 meters or more is considered out of isolation during the day. All information is anonymous, respecting users' privacy and collaborating to elaborate public policies that improve social isolation measures to face the COVID-19 pandemic.

The research was disseminated in social media (Instagram, Facebook, and Twitter) and sent by email. An anonymous online questionnaire (Microsoft Forms) was used for data collection, including all validated questionnaires proposed for research, without any changes to the original version. All questionnaires were accessible through any device with access to the internet. The "snowball" sampling method was used to recruit more participants. The online survey was made available via social media and randomly dispersed to as many people as possible, during April 27 and May 25, 2020. A survey conducted in 2019 revealed that in the State of São Paulo, 77% of the population ≥ 10 y of age was considered as internet users, corresponding to about 30.5 million people. On the other hand, almost 20% of the population had never accessed the internet. Taking into account household and fixed internet, about 66% of the residences had internet access. Regarding residences located in high social vulnerability areas, 37% of those did not have this type of connection (about 1.6 million homes) [20].

During the data collection period, the researchers were available to answer any questions from the participants by phone, messages, or email. The study protocol and the procedures of the free-informed consent were carried out following the last revised Helsinki Declaration, approved by the Human Research Ethics Committee of the Federal University of São Paulo (number: 0859/2020). As inclusion criteria, we enrolled adult subjects (18–59 years old) of both sexes, who lived in the State of São Paulo, being able to answer online questionnaires. It is essential to highlight that the Brazilian Elderly Statute considers people ≥ 60 years old as aged, contrarily to international references (> 64 y). Moreover, as an inclusion criterion, we requested participants to answer the questionnaire only if they were confined at home, leaving the house only for essential services (market, pharmacy, and hospital). Shift workers and health professionals who were directly working with patients with COVID-19 were excluded.

Dependent variable

Assessment of dietary practices

The Dietary Practices Measurement Scale [21] consists of 24 items that exemplify dietary practices (planning, domestic organization; food choice; ways of eating) in agreement or disagreement with the recommendations of the Dietary Guidelines for the Brazilian Population (DGBP) [22]. The possible answers to each item are as follows: *strongly disagree*; *I disagree*; *I agree*; *strongly agree*, whether or not they endorse such a practice in their daily lives. The scale's score (Likert-type scale) is computed by the simple sum of the answers to which values from 0 to 3 are assigned, varying from 0 to 72 as the maximum value. The 13 items aligned with the recommendations of the DGBP are scored so that the answer with the complete agreement is the one with the highest value (*strongly agree* = 3 points); the 11 items opposed to the DGBP recommendations are scored inversely (*strongly disagree* = 3 points). For classification purposes, two cutoff points were defined, based on score percentiles, generating three score ranges: first tertile (< 32 points); second tertile (32–41 points); third tertile (> 41 points).

The higher the score, the greater the participant's adherence to the DGBP recommendations. Among the questions which considered best dietary practices, the following topics were included:

- Meal planning;
- Variation of food consumption;
- Meal preparation;
- Meals at home and eating at the table;
- Eating meals calmly; and
- Consumption of fruits, nuts, organic vegetables, and preference for the purchase of food by local suppliers.

Questions related to the worst dietary practices were as follows:

- The use of mealtimes to carry out other activities;
- Eating meals at the work or study table, on the sofa or in bed;
- Consumption of sugary drinks, chocolates, candies; eating snacks between meals;
- Replacement of main meals such as lunch and dinner;
- Frequency of consumption of sandwiches and pizzas and frequency of consumption of fast foods in general.

Independent variables

Eating behavior

To analyze aspects related to eating behavior, we used the Three-factor eating questionnaire (TFEQ)-R21 [23]. The TFEQ-21 was translated and validated for the Brazilian population [24]. The TFEQ-21 is a self-assessment questionnaire developed to measure cognitive and behavioral components of eating: emotional eating (EE), cognitive restraint (CR), and binge eating (BE). The TFEQ-21 comprises 21 questions on a 4-point Likert scale for items 1 to 20 and an 8-point numerical rating scale for item 21. Responses to each of the items are given a score between 1 and 4. Before calculating domain scores, items 1 to 16 were reverse-coded, and item 21 was recorded as follows: 1 to 2 scores as 1; 3 to 4 as 2; 5 to 6 as 3; 7 to 8 as 4. EE includes six items that measure the propensity to overeat in response to negative emotions, such as anxiety, depression, and loneliness. CR includes six items concerning several factors related to food intake and body mass changes. BE includes nine items that analyze the individual's tendency to ingest high amounts of food, generally triggered by some external stimulus during a short time. Higher scores were indicative of more excellent EE, CR, and BE.

Physical exercise and body mass index

Participants were asked if they practiced physical exercise. In case of a positive answer, they had to report if they had continued to practice it at home. For this item, we did a dichotomous self-report of practice, being yes for "I continued practicing exercises at home during confinement" and no for "I did not continue practicing exercises at home during confinement."

We asked for self-reported current body mass (kg) and the participants' height (m) and considered the last measurement performed. In the statistical analysis, the normal weight (body mass index [BMI] between >18.5 and 24.99 kg/m^2) was considered as a reference for comparisons with the categories low weight ($>18.5 \text{ kg/m}^2$), overweight (≥ 25 – 29.99 kg/m^2), and obesity ($\geq 30 \text{ kg/m}^2$).

Sleep duration and quality assessment

The Pittsburgh Sleep Quality Index (PSQI) questionnaire was used to assess sleep time and quality [25]. The PSQI was translated and validated for the Brazilian population (PSQI-BR) in 2011 by Bertolazi et al. [26]. The questionnaire consists of 19 self-reported questions that measure seven components, namely, subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disorders, use of sleeping medication, and daytime sleep dysfunction in the previous month. The scores of the seven components are added up, resulting in the global score, ranging from 0 to 21 points. A PSQI score of >5 indicates low overall sleep quality. Accordingly, PSQI was grouped to scores of ≤ 5 and >5 in the regression analyses. According to Buysse et al. [25], a global PSQI score >5 provides a sensitive and specific measure of poor sleep quality compared with laboratory measures and indicates that the individuals have severe difficulties in at least two domains or moderate difficulties in more than three domains.

Chronotype evaluation

The Horne and Ostberg Morningness-Eveningness Questionnaire (MEQ) was used for assessing chronotype [27]. We used the Portuguese version (MEQ-BR) validated in 1990 by Benedito-Silva et al. [28]. The MEQ-BR investigates human circadian behavior related to sleep habits and preferences for performing specific tasks during the day. The MEQ-BR consists of 19 multiple-choice questions with four answer options, and the final score allows determining which chronotype the individual belongs to, definitely morning type (70–86), moderate morning type (59–69), indifferent (42–58), moderate evening type (31–41), and definitely evening type (16–30). Therefore, the lowest score indicates evening chronotype and the highest score indicates morning chronotype.

Covariates and confounders

To consider covariates and confounder effects, we verified the sex, age, educational, and economic level of each participant. Covariates of sex (male or female) and age (years) were evaluated in a dichotomous and continuous fashion, respectively. Confounder's educational level and socioeconomic status variables were assessed. Educational level was categorized as graduated / not graduated from high school; graduated / not graduated from college; postgraduate education. For statistical analysis, the first category (graduated / not graduated from high school) was used as a reference. The socioeconomic status was determined according to the classification of the Brazilian Institute of Geography and Statistics, being ≤ 2 Brazilian minimum wages (US \$366.02), from 2 to 4 Brazilian minimum wages (US \$366.03 to US \$732.05), from 4 to 10 Brazilian minimum wages (US \$732.06 to US \$1830.12), 10 to 20 Brazilian minimum wages (US \$1830.13 to US \$3660.25), and >20 Brazilian minimum wages (US \$3660.26). The amount referring to the current Brazilian minimum wage is R\$1.045,00 (US \$183.01).

Statistical analysis

Descriptive statistics were used to assess the sample characteristics: mean, standard deviation (SD), and percentage. One-way analysis of variance (ANOVA) plus Tukey post hoc test were used to compare differences between tertiles. Partial eta squared (η_p^2) effect sizes for ANOVA and Cohen's d effect sizes for pairwise comparisons were used to verify the magnitude of the differences. Pearson's correlation analysis was performed to verify the relationship between continuous variables. Moreover, we performed a generalized linear model (GLM) with Gaussian distribution and identity link function due to better fit according to the Akaike information criterion (AIC). The lowest value obtained by AIC indicates that the assumption of normality of residues has better been met. AIC estimates the quality of each model compared with the other models proposed. η_p^2 were used (0.01, small effect size; 0.06, medium effect size; 0.14, large effect size) as an estimate of the effect size of the predictor variables in the regression. The outcome variable was dietary practices, and exposure variables were three-factor eating questionnaire, physical exercise, BMI (kg/m^2), PSQI, and chronotype; moreover, sex, age, socioeconomic and educational levels were used as covariates and confounders. All statistical analysis was performed using Jamovi 1.2.27 version. The significance level was set at $P < 0.05$ for all analyses.

Results

Sample characteristics

In this cross-sectional study, 773 individuals answered the questionnaire voluntarily and anonymously within the defined period. After careful reading of all answers, 724 (585 women and 139 men) adult participants were included in the data analysis. Women comprised most of the sample (80.8%), with 75, 78.24%, and 83.54% in the first, second, and third tertiles, respectively. Mean age was 32.6 y (± 11.3) for women and 33.5 y (± 10.5) for men. The mean BMI was 25 kg/m^2 (± 4.71) for women and 26 kg/m^2 (± 4.75) for men. Assessing sleep time by tertiles, the average sleep time in the first, second and third tertiles was 7.19 h (± 1.49), 7.15 h (± 1.46), and 7.46 h (± 1.45), respectively.

There was no difference in age between tertiles ($F_{2,721} = 1.66$; $P = 0.191$; $\eta_p^2 = 0.005$). Body mass ($F_{2,721} = 21.2$; $P < 0.001$; $\eta_p^2 = 0.058$) and BMI ($F_{2,721} = 19.1$; $P < 0.001$; $\eta_p^2 = 0.053$) differed between tertiles. The body mass of the third tertile was lower compared with the first (MD = 9.39; $t = 5.07$; $P < 0.001$; $d = 0.62$) and the second (MD = 6.68; $t = 5.23$; $P < 0.001$; $d = 0.44$) tertiles. The same could be observed with BMI, being lower in the third tertile compared with the first (MD = 2.52; $t = 4.44$; $P < 0.001$; $d = 0.54$) and second (MD = 2.05; $t = 5.27$; $P < 0.001$; $d = 0.44$) tertiles. We found that sleep time ($F_{2,721} = 3.77$; $P = 0.023$; $\eta_p^2 = 0.010$) and efficiency ($F_{2,721} = 7.00$; $P < 0.001$; $\eta_p^2 = 0.021$) differed between tertiles. The sleep time of the second tertile was shorter compared with the third tertile (MD = 0.308; $t = 2.58$; $P = 0.027$; $d = 0.21$). The sleep efficiency of the third tertile was higher than the first (MD = 5.73; $t = 3.22$; $P = 0.004$; $d = 0.41$) and second (MD = 3.12; $t = 2.65$; $P = 0.023$; $d = 0.22$) tertiles. Finally, chronotype differed between groups ($F_{2,721} = 11.3$; $P < 0.001$; $\eta_p^2 = 0.030$). The MEQ

Table 1
Baseline characteristics stratified by dietary practices score (N = 724)

Variables		Dietary practices		
		First tertile (<32 points)	Second tertile (32–41 points)	Third tertile (>41 points)
Sample size	724	84	239	401
Sex, n (%)				
	Men	21 (25)	52 (21.75)	66 (16.46)
	Women	63 (75)	187 (78.24)	335 (83.54)
Dietary practices score		26.19 ± 5.02	37.15 ± 2.66	49.70 ± 5.75
Age (y)		42.33 ± 18.44	37.47 ± 19.21	32.19 ± 10.55
Weight (kg)		75.40 ± 20.6*	72.7 ± 17.1*	65.98 ± 12.3
BMI (kg/m ²)		26.75 ± 6.08*	26.28 ± 5.28*	24.23 ± 3.76
EE score		52.3 ± 28.7*	48.5 ± 25.4*	33.5 ± 24.3
BE score		50.1 ± 21.6* [†]	41.9 ± 17.7*	30.2 ± 17.2
CR score		34.9 ± 17.5* [†]	45.9 ± 17.9*	49.7 ± 20.9
Physical activity, n (%)				
	Yes	20 (23.80)	95 (39.75)	259 (64.59)
	No	64 (76.20)	144 (60.25)	142 (35.41)
Sleep time (h)		7.19 ± 1.49	7.15 ± 1.46*	7.46 ± 1.45
Sleep efficiency (%)		81.8 ± 13.6*	87.3 ± 14.5	88.9 ± 13.5
Chronotype MEQ score		49.6 ± 11.9*	50.9 ± 11.1*	54.5 ± 11.2

ANOVA, analysis of variance; BE, binge eating; BMI, body mass index; CR, Cognitive restraint; EE, emotional eating; MEQ, Morningness – Eveningness Questionnaire; PSQI, Pittsburgh Sleep Quality Index.

Data expressed as mean ± SD, unless otherwise noted.

One-way ANOVA plus Tukey post hoc.

*Statistically different from the third tertile.

[†]Statistically different from the second tertile.

score in the third tertile was higher than the first (MD = 4.92; $t = 3.63$; $P < 0.001$; $d = 0.43$) and second (MD = 3.59; $t = 3.89$; $P < 0.001$; $d = 0.31$) tertiles.

the second tertile compared with the first tertile (MD = 8.17; $t = 3.59$; $P = 0.001$; $d = 0.45$).

Eating behavior

The dimensions of eating behavior assessed by the TFEQ-21 differed statistically between tertiles (Table 1). We found that the three dimensions of behavior differed between tertiles. EE ($F_{2,721} = 36.9$; $P < 0.001$; $\eta_p^2 = 0.093$), CR ($F_{2,721} = 20.1$; $P < 0.001$; $\eta_p^2 = 0.053$), and BE ($F_{2,721} = 60.02$; $P < 0.001$; $\eta_p^2 = 0.143$). We verified that EE was lower in the third tertile compared with the first (MD = 18.8; $t = 6.24$; $P < 0.001$; $d = 0.74$) and second (MD = 15; $t = 7.30$; $P < 0.001$; $d = 0.59$) tertiles. In contrast, CR was higher in the third tertile compared with the first (MD = 14.79; $t = 6.29$; $P < 0.001$; $d = 0.75$) and second (MD = 3.78; $t = 2.36$; $P = 0.049$; $d = 0.19$) tertiles. Still, CR was higher in the second tertile compared with the first tertile (MD = 11; $t = 4.43$; $P < 0.001$; $d = 0.56$). Finally, BE was lower in the third tertile compared with the first (MD = 19.9; $t = 9.27$; $P < 0.001$; $d = 1.11$) and second (MD = 11.7; $t = 8.03$; $P < 0.001$; $d = 0.65$) tertiles. Moreover, BE was lower in

Correlation analyzes

In the correlation analyses (Table 2), EE and BE were positively correlated ($r = 0.66$; $P < 0.001$; moderate), as were BMI and BE ($r = 0.27$; $P < 0.001$; weak). Dietary practices were negatively correlated with BE ($r = -0.41$; $P < 0.001$; weak), EE ($r = -0.33$; $P < 0.001$; weak), and BMI ($r = -0.24$; $P < 0.001$; weak). BMI was positively correlated with EE ($r = 0.27$; $P < 0.001$; weak). Sleep time was positively correlated with dietary practices ($r = 0.082$; $P = 0.029$; weak) and negatively correlated with BMI ($r = -0.17$; $P < 0.001$; weak). Sleep efficiency was negatively correlated with EE ($r = -0.098$; $P = 0.011$; weak) and positively correlated with dietary practices ($r = 0.165$; $P < 0.001$; weak). PSQI quality score was positively correlated with EE ($r = 0.20$; $P < 0.001$; weak), CR ($r = 0.13$; $P < 0.001$; weak), and BE ($r = 0.16$; $P < 0.001$; weak).

Table 2
Pearson's correlation matrix

Variables	BE; r (P -value)	CR; r (P -value)	EE; r (P -value)	BMI; r (P -value)	Dietary practices r (P -value)	Sleep time r (P -value)	Sleep efficiency r (P -value)	PSQI r (P -value)
BE score	–							
CR score	–0.052 (0.160)	–						
EE score	0.668 (<0.001)	0.067 (0.072)	–					
BMI (kg/m ²)	0.269 (<0.001)	0.150 (<0.001)	0.272 (<0.001)	–				
Dietary practices	–0.415 (<0.001)	0.201 (<0.001)	–0.337 (<0.001)	–0.241 (<0.001)	–			
Sleep time (h)	–0.058 (0.122)	–0.055 (0.138)	–0.036 (0.328)	–0.178 (<0.001)	0.082 (0.029)	–		
Sleep efficiency (%)	–0.049 (0.207)	–0.041 (0.291)	–0.098 (0.011)	–0.093 (0.019)	0.165 (<0.001)	0.606 (<0.001)	–	
PSQI score	0.169 (<0.001)	0.169 (<0.001)	0.204 (<0.001)	0.146 (<0.001)	–0.193 (<0.001)	–0.481 (<0.001)	–0.614 (<0.001)	–

BE, binge eating; BMI, body mass index; CR, cognitive restraint; EE, emotional eating; PSQI, Pittsburgh Sleep Quality Index.

Correlation coefficient performed by Pearson's correlation test.

P -values in bold ≤ 0.05 .

Table 3
Multiple linear regression

Independent variables	Multiple linear regression*				
	Estimate	SE	95% CI	t	P-value [†]
Intercept	42.2245	0.9709	40.3217 to 44.1273	43.492	<0.001
3-factor eating questionnaire					
Emotional eating	-0.0487	0.0171	-0.0823 to -0.0151	-2.841	0.005
Cognitive restraint	0.0673	0.0175	0.0331 to 0.1015	3.858	<0.001
Binge eating	-0.1286	0.0229	-0.1735 to -0.0836	-5.612	<0.001
Physical exercise	-4.1137	0.6934	-5.4727 to -2.7546	-5.933	<0.001
BMI (kg/m ²)					
Low vs normal weight	-1.5720	2.4711	-6.4152 to 3.2712	-0.636	0.525
Overweight vs normal weight	-1.9751	2.5514	-6.9757 to 3.0255	-0.774	0.439
Obese vs normal weight	-2.8915	2.6641	-8.1130 to 2.3300	-1.085	0.278
PSQI Score (>5 is the reference)	1.7031	0.6795	0.3713 to 3.0349	2.506	0.012
Chronotype					
Matutine vs intermediate	-0.5153	1.5309	-3.5158 to 2.4852	-0.337	0.737
Moderate matutine vs intermediate	-1.9421	1.4580	-4.7996 to 0.9154	-1.332	0.183
Moderate vespertine vs intermediate	-3.3084	1.5938	-6.4323 to -0.1845	-2.076	0.038
Vespertine vs Intermediate	-4.7038	2.2261	-9.0668 to -0.3407	-2.113	0.035
Sex (men vs women)	-3.1564	0.8475	-4.8174 to -1.4954	-3.725	<0.001
Age	-0.0729	0.0330	-0.1375 to -0.0082	-2.210	0.027
Socioeconomic status					
2–4 salaries vs ≤2 salaries	1.1622	0.9292	-0.6591–2.9834	1.251	0.212
4–10 Salaries vs ≤2 salaries	2.4732	0.9610	0.5896–4.3568	2.573	0.010
10–20 salaries vs ≤2 salaries	4.3246	1.1607	2.0496–6.5996	3.726	<0.001
>20 salaries vs ≤2 salaries	2.3082	1.5785	-0.7856–5.4020	1.462	0.144
Educational level					
University graduate vs up to high school	1.0975	1.3985	-1.6434–3.8385	0.785	0.433
Postgraduate vs up to high school	3.0499	1.7080	-0.2976–6.3974	1.786	0.075

BMI, body mass index; PSQI, Pittsburgh Sleep Quality Index.

*Generalized linear model (GLM)/linear regression test was used.

[†]P-values in **bold** ≤ 0.05.

Regression analysis

The regression with Gaussian distribution and identity link function, whose AIC is 4340,811, explained a significant proportion of variance in dietary practices score (adjusted $R^2 = 0.332$; $F_{20, 599} = 16.4$; $P < 0.001$; $\eta_p^2 = 0.354$; Table 3). Considering the domains of eating behavior, we verified that EE ($\beta = -0.1351$; $t = -2.841$; $P = 0.005$; $\eta_p^2 = 0.013$), CR ($\beta = 0.1407$; $t = 3.858$; $P < 0.001$; $\eta_p^2 = 0.024$), and BE ($\beta = -0.2580$; $t = -5.612$; $P < 0.001$; $\eta_p^2 = 0.050$) significantly predicted dietary practices score. Moreover, not practicing physical exercise at home during social isolation ($\beta = -0.4271$; $t = -5.933$ $P < 0.001$; $\eta_p^2 = 0.055$), score <5 points on the PSQI ($\beta = 0.1768$; $t = 2.506$; $P = 0.012$; $\eta_p^2 = 0.010$), being vespertine ($\beta = -0.3435$; $t = 2.076$ $P = 0.038$; $\eta_p^2 = 0.019$), and being extremely vespertine ($\beta = -0.4883$; $t = -2.113$ $P = 0.035$; $\eta_p^2 = 0.019$) significantly predicted dietary practices score. Finally, being male ($\beta = -0.3277$; $t = -3.725$ $P < 0.001$; $\eta_p^2 = 0.023$), age ($\beta = -0.082$; $t = -2.210$; $P = 0.027$; $\eta_p^2 = 0.008$), receiving 4 to 10 wages per month ($\beta = 0.2568$; $t = 2.573$; $P = 0.10$; $\eta_p^2 = 0.027$) and 10 to 20 wages per month ($\beta = 0.4490$; $t = 3.726$; $P < 0.001$; $\eta_p^2 = 0.027$) significantly predicted dietary practices score.

In summary, we identified that EE, BE, not practicing physical exercise at home, being vespertine, being a man, and age are negative predictors of dietary practices. On the other hand, CR, better sleep quality, receiving 4 to 10 or 10 to 20 salaries per month are positive predictors of dietary practices.

Discussion

The present study aimed to verify the prevalence of lifestyle factors, eating behavior dimensions, and chronotype, and to

explore associations among dietary practices in home confinement during the COVID-19 pandemic. Recently published studies have discussed the complexity of evaluating behavioral aspects during stressful situations such as the COVID-19 pandemic. Considering that intrinsic factors (i.e., age, years of life left, multimorbidity, anxiety, fear, dealing with social distance, etc.) and extrinsic factors (i.e., poverty, food insecurity, private versus public health services, etc.) interact, any interpretation must be made cautiously [29].

To the best of our knowledge, this was one of the first studies to assess factors associated with dietary practices evaluated according to the DGBP recommendations during the social isolation period caused by the COVID-19 pandemic in Brazil. The results shown here could help understand the main predictive factors for dietary practice changes to promote early strategies for guidance during situations of confinement by viruses or other reasons. We identified that EE, BE, not practicing physical exercise at home, being vespertine, being a man, and age are negative predictors of dietary practices. In contrast, CR, better sleep quality, receiving 4 to 10 or 10 to 20 salaries per month are positive predictors of dietary practices during home confinement [30]. We verified that women represent approximately 81% of the sample in the present study. Accordingly, Di Renzo et al. [11] found that 76.1% of women answered the online questionnaire proposed during COVID-19. Previous studies suggest that women participate in more surveys than men [31].

It is essential to consider that the highest rate of social isolation in São Paulo's state was 59%; however, this rate was reached only on weekends, the most common period of social confinement. Social isolation is characterized by stress, and individual perception of stress can lead to dietary changes. Animal [32] and human [33] studies have previously shown that isolation can affect food intake, suggesting that this current scenario, due to COVID-19, may

lead to changes in dietary practices. In an animal model, stress leads to hyperphagia and hypophagia [32,34]. The same seems to be observed in humans, a 40% increase or decrease in energy intake in stressful situations, whereas approximately 20% of people do not change feeding behaviors during a stressful period [33,35–38]. This variation seems to be associated with the magnitude and time of exposure to stress [38].

Kry and Cordeira [39] verify that socially isolated female mice consumed more high-sweet and high-fat food than pair-housed mice. Paradoxically, in humans, less social contact and living alone can also result in less energy consumed and less food variety, with reduced intake of fruits and vegetables [40]. Therefore, not all people may increase their energy intake during social isolation, but it is possible that some choose unhealthy foods.

Understanding food choices is essential, although it is typical during stressful situations to observe a high intake of more palatable foods rich in fat and sugar, including ultraprocessed foods. Animal and human studies have shown that palatable food preference is more significant in stressful situations [35,41–43]. Dysregulation of the hypothalamic–pituitary–adrenal axis increases cortisol release and may, at least in part, explain the increase in food intake [44]. Brain mechanisms, with greater activation of orexigenic neuropeptides, could help understand why stress increases food intake [45]. There is also a relationship between stress and reward mechanisms [46] that can be explained by the high corticotrophin-releasing hormone (CRH) levels. CRH promotes an increase in dopaminergic activity, which alleviates stress, increasing hedonically pleasant food [47].

Social isolation exacerbated negative emotions (i.e., sadness, anxiety, fear). These emotions are linked to food intake, mainly for compensatory purposes, generating a comfort sensation [48]. We verified that EE and BE were negative predictors for dietary practices. We also found that EE and BE were positively associated. EE and BE seem to be linked to the difficulty of dealing with feelings in a stressful scenario, changing food consumption [49–52]. Therefore, it is expected that stressful situations increase EE [53], leading to episodic situations of BE [54]. It is believed that BE alleviates the negative feelings generated by a stressful situation [54]. BE is characterized by short-time high food intake [55] and has a complex etiology triggered by various social, cultural, biological, and environmental factors. Several studies showed that the perception of stress (i.e., social isolation) increases BE [56–59].

On the other hand, we found that CR was positively associated with dietary practices. This behavior may be related to the concern with increasing weight and changing appearance [60,61]. Studies suggest that CR is associated with increased vegetable intake and preference for healthy foods, in line with the data from the present study [62].

Ingram et al. [63] revealed that the social isolation generated by COVID-19 harmed physical activity practices and decreased sleep quality. Likewise, Martínez-de-Quel et al. [64], who evaluated the effects of COVID-19 lockdown on physical activity, dietary habits, and sleep quality longitudinally, found that active individuals reduced their physical activity level and worsened their sleep quality compared with a physically inactive group, suggesting that more active individuals were more affected during social isolation. Our data shows that not exercising at home is a negative predictor for dietary practices. This data corroborates the positive historical relationship between physical exercise and better food choices, encourages the importance of this wedding during social isolation. Our data agree with the findings of Amatori et al. [65], in which the authors found that exercise was associated with better dietary practices (increased intake of fruits, vegetables, and fish), with a positive mediating exercise effect on mood and improvement in

food choices during COVID-19 home isolation in Italian college students. These authors also found that a poor mood state leads to worse eating habits.

Although our data are cross-sectional, it is essential to encourage exercise practice as it has been estimated that 53% of adult deaths occur, at least in part, due to inappropriate lifestyle habits, which include physical inactivity and unhealthy diet [66,67]. There are several effects of physical exercise on food intake. First, physical exercise changes homeostatic regulation between ghrelin and leptin. Moreover, better food choices are associated with exercise practice [68–70]. Joo et al. [71] found, in a 15-wk intervention study, that physical exercise was associated with more healthy dietary patterns. The authors showed that exercise was positively associated with more "prudent" (i.e., milk, cereals, fruits, vegetables, and low-fat foods) dietary patterns, whereas consumption of fried foods and sugary drinks decreased. Donati Zeppa et al. [72] found that 9 wk of high-intensity interval training promoted spontaneous best food intake in young normal weight individuals. The authors believe that this effect is attributed to the complex and positive interaction between physical exercise and neurocognitive processes, leading to behavior changes, including mood improvement and healthier food intake. Likewise, Andrade et al. [73] demonstrated that after 12 mo of behavioral intervention, including physical exercise, women reduced emotional overeating, strengthening the positive relationship between physical exercise and best eating practices.

Moreover, periods of inactivity (restless), boredom, anxiety, and worries can increase feelings that may trigger high-fat and high-sugar food intake, capable of generating, even temporarily, sensations of pleasure and well-being [74,75]. Moynihan et al. [74] showed that boredom was associated with a greater intake of energy, carbohydrate, fat, and protein. These authors also verify that boredom may increase the desire to snack. Therefore, loneliness and social isolation predict lower physical activity levels [76,77], increasing the consumption of unhealthy foods with large amounts of sugar and fat.

It is essential to consider that lifestyle factors (i.e., physical exercise, sleep time, and food habits) interact. For example, physical inactivity and poor sleep quality can share a bidirectional relationship [13]. Still, short sleep time was associated with high energy, sugar, and fat intake [78].

According to the PSQI score, we showed that better sleep quality was associated with a higher dietary practice score. Several previous data showed that short sleep time or poor sleep quality could affect the homeostatic hormonal system, increasing ghrelin and decreasing leptin levels [79]. Additionally, short sleep time increases the reward system, leading to the intake of more palatable foods [80–83]. Greer et al. [81] verified that sleep deprivation significantly reduced activity in three cortical regions (i.e., anterior cingulate cortex, lateral orbital frontal cortex, and anterior insular cortex), increasing food desire. We found a positive correlation between sleep quality, EE, and BE and a negative correlation between sleep quality and dietary practices, suggesting that inadequate sleep could affect food intake through stress-linked pathways. Interestingly, sleep deprivation resulted in a significant increase in the proportion of "wanted" foods with high-caloric content. Fenton et al. [84] systematically reviewed the effect of sleep on food intake, and it was found that short sleep duration promotes high energy intake.

In the chronotype analysis, we found that the MEQ score of the third tertile is higher than the scores of the first and second tertiles. This data suggests that the morning chronotype may be associated with better dietary practices. Besides, moderately and extremely evening chronotypes were negative predictors of dietary practices.

Other studies have shown an association between vespertine chronotype and an unhealthy diet [85–87]. Previous data demonstrated lower overall appetite in the morning than in the evening, which may justify the lowest dietary practices score for the evening chronotype [88].

Interestingly, considering the endogenous circadian rhythm in appetite, evening hunger is more independent of wake time and energy intake [89]. Moreover, recent studies suggest changes in sleep patterns and chronotype during the COVID-19 pandemic [90]. Some authors found that bedtime did not change, but that these individuals sleep longer [91]. Others found that sleep onset and offset were delayed on weekdays, and despite the longer time in bed, sleep quality worsened during the lockdown [90,92].

Lifestyle factors are interconnected with a complex matrix of external factors, such as sex, educational level, and socioeconomic status. We considered the interpretation of this relationship to be fundamental. Several studies suggest that women are more concerned with health and, although they are more influenced by emotions and may have more EE and BE, they may have dealt with stress better. However, other data suggest that men prefer low-calorie foods [93]. Although the mechanisms are not entirely elucidated, animal model studies suggest that female rats exposed to stress can exhibit behavioral adaptation, whereas male rats cannot [94]. However, in humans, stress seems to affect food choices, its intake, and decisions that precede eating, especially in women.

The scenario generated by social isolation due to COVID-19 is multifaceted and can affect dietary practices. Individuals with higher income, higher educational level, and better access to food may maintain or improve their dietary practices, whereas those in an environment of food insecurity due to various intrinsic or extrinsic factors, have maintained or worsened their dietary practices. Our data corroborate the social factor's importance as our results revealed that receiving between 4 to 10 and 10 to 20 salaries per month is a positive predictor of better dietary practices. Food insecurity has been widely discussed in the literature, and it is suggested that better social conditions enable better food choices [95].

In recent months, population has experienced more flexible social isolation policies; however, it can be considered that the effects of the COVID-19 pandemic on economic aspects will remain for months or years, harming dietary practices, especially for low-income workers [17]. Individuals in a situation of food insecurity tend to suffer more in these conditions. Food insecurity is even considered a stressful situation (i.e., where and how to access food) and associated with worse dietary practices and an increased risk for health problems [96,97]. In a food insecurity scenario, the choice for cheaper foods, generally high in fat, sodium, and sugar, is more significant, explaining metabolic dysregulations related to glycemic, blood pressure, and lipemic levels [98,99]. Our findings that individuals who are socially vulnerable are most affected during confinement by COVID-19 are in line with other studies [64]. Still, individuals living with a preexisting chronic metabolic disorder will have more difficulty managing health status, especially when a dietary factor is crucial for maintaining health [17].

The present study had some limitations. The “snowball” sampling method used to recruit more participants may have produced recruitment bias, mainly because internet access was not adequate in all cities in São Paulo. The cross-sectional design did not allow us to guarantee a causal relationship between the variables. We only used psychometric measurements to assess eating behavior and eating practices, with no diet monitoring.

Conclusion

We found that during home confinement brought on from the COVID-19 pandemic in São Paulo, Brazil, EE, BE, male sex, and not exercising at home were negative predictors for dietary practices. In contrast, CR, better sleep quality, and higher salaries were positive predictors for dietary practices. Although the present study was cross-sectional in design, social isolation has adverse effects on dietary practices, and lifestyle factors (physical exercise and sleep) may be decisive in this relationship. Additionally, it is necessary to consider that in situations of persistent food insecurity, dietary practices may worsen, increasing the risk of developing metabolic disorders. Finally, it is essential to consider that our findings are only generalizable to populations with similar characteristics.

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