Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Original article

Anxiety is more related to inadequate eating habits in inactive than in physically active adults during COVID-19 quarantine

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SUMMARY

Background & aims: Anxiety can be related to reduced diet quality during pandemics such as COVID-19. However, it is not clear whether these relationships would be similar in inactive and physically active participants. The aim of this study was to analyze associations between anxiety and eating habits in physically active and inactive individuals during the COVID-19 pandemic.

Methods: The sample consisted of 1826 adults (58.5% women) who were invited through social media to answer an online questionnaire. The instrument included questions related to physical activity, eating habits, health behavior, mental health (anxiety, depression, self-esteem, sadness and stress) and overall health. Anxiety, food habits (high food habits consumption ≥5 times per week) and physical activity (≥150 min per week) were assessed during the COVID-19 pandemic. The relationship between anxiety and eating habits according to levels of physical activity (inactive vs. active) was assessed using binary logistic regression adjusted for sex, age, education level, social isolation, and body mass index.

Results: Among the inactive participants, anxiety was related with high consumption of sweets (OR = 1.43; 95% CI = 1.11–1.83) and fast foods (OR = 2.23; 95% CI = 1.05–4.74) while quarantining during the COVID-19 pandemic. No relationship was observed between anxiety and food consumption among physically active participants in the final model.

Conclusion: Anxiety was associated with less desirable eating habits among physically inactive adults during the COVID-19 pandemic.

1. Introduction

The beginning of the COVID-19 pandemic resulted in the World Health Organization (WHO) recommending social isolation and quarantining to contain the spread of the virus [1].

In accordance with these guidelines, Brazil instituted stay-at-home orders resulting in working professionals being required to telecommute, children to attend school remotely, and the suspension of non-essential activities such as restaurant dining, travelling for leisure, and cultural events [2].

Due to concerns about the pandemic and social isolation, an increase in global anxiety levels has been reported [3–5]. Social isolation has negatively impacted adults' emotional health by increasing stress and anxiety. Specific stressors included longer social isolation, separation from loved ones, the loss of freedom, fears of infection, frustration, boredom and inadequate information about the pandemic [6]. Additionally, anxiety and stress impact hunger, the desire to eat and food choices [7]. As a result, anxiety may increase impulsive eating behaviors, resulting in increased daily caloric intake through higher consumption of high calorie

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foods, such as sweets, fried foods, fast foods, and ultra-processed products [8,9]. Kaya et al. [10] reported that anxiety and fear during the pandemic was associated with changes in nutritional habits and food preferences in adults. During COVID-19, individuals with pre-existing physical and mental health conditions are at a higher risk of maladaptive food behaviors while under stress [11]. Others have found similar results indicating a higher prevalence of unhealthy eating habits during the pandemic, as well as physical inactivity and mental health impairments [12,13].

However, it has been reported that those that remain physically active during the pandemic reported lower levels of anxiety [14]. Global recommendations state that adults need to perform at least 150 min per week of moderate-to-vigorous physical activity [15], and regular physical activity reduces anxiety levels [16]. Additionally, higher physical activity levels among adults were associated with healthy eating habits prior to [17–19] and during the COVID-19 pandemic [20].

The association between poorer mental health situations, changes in lifestyle habits and unhealthy eating habits could be a public health burden during the COVID-19 pandemic. However, it is not clear if the association between anxiety and eating habits could be influenced by physical activity levels.

Thus, the present study analyzed the association between anxiety and eating habits among adults according to physical activity levels during the COVID-19 pandemic.

2. Methods

2.1. Study design, sample and ethics

A survey was distributed among Brazilian adults (≥18 years) between May 5th and May 17th, 2020. Participants were invited through social media (WhatsApp, Instagram, Twitter, Facebook) to answer an online questionnaire using the Google Forms platform (Mountain View, CA, USA). Data were then transferred to an MS Excel 2019 spreadsheet (Redmond, WA, USA) for further analysis. To calculate the sample size, a prevalence of anxiety (38.2%) [21], power of 80% and alpha error of 3% were used, which generated a minimum sample of 1503 participants.

This study was approved by the Universidade Nove de Julho' Ethics Committee before data collection (CAAE #30890220.4.0000.5511 approved on May 1st, 2020). Participants did not identify themselves and their answers were only included in the sample if informed consent was provided. All procedures follow national legislation and the Declaration of Helsinki. Only those that responded to all survey questions were included in the analysis.

2.2. Procedures

The questionnaire was developed by senior researchers with PhDs in different areas (Nutrition, Physiology, Public Health, Human Movement Science, Neuroscience and Behavior). The instrument adopted for this study consisted of 70 questions and included the following domains: personal information, personal care, physical activity, eating behavior, and mental health. Following we present the questions used in the present analysis. The online survey methodological characteristics are available in previous published studies [3,20,22–24].

2.3. Dependent variable - anxiety

To assess anxiety, participants were asked: "Due to COVID-19, are you feeling more anxious than usual? (Possible answers: No, A little, Sometimes, Very often, or Always"). Participants who answered "no" and "a little" were collapsed into a new variable, "Not Anxious", while those who answered "sometimes", "very often" or "always" were collapsed into a separate variable, "Anxious". The use of this instrument has been previously reported in literature [3].

2.4. Independent variables – eating behavior and physical activity

To explore eating habits, the following question was asked: "How many days in a week do you eat fruits?" (Possible answers: "none" to "seven days a week"). Similarly structured questions were also asked concerning the consumption of vegetables, cereals, grains, fried foods, red meat, fast food, and sweets. These questions were adapted from the questionnaire by Block et al. [25,26] and has been previously reported in literature [20]. Food consumption was collapsed into a separate variable ("Weekly Food Consumption") whereby consuming foods five times per week or more was considered high consumption and less than five times per week was defined as low consumption [27].

To assess physical activity, the following were considered: i) weekly frequency (0–7 days); ii) amount of time exercising (none; less than 30 min; between 30 and 60 min, and; more than 60 min); iii) how long have I practiced physical activity (less than 1 month; between 1 and 3 months; between 3 and 6 months; more than 6 months and; I'm not exercising); iv) intensity (low; moderate; high; or, I'm not exercising); v) type of exercise (walking/jogging; resistance training; core exercise; I am not exercising; others – open question). The use of this instrument has been previously reported [20].

To assess exercise regularity, time spent during each exercise session during the week was multiplied by the number of days spent exercising each week. Those that reached 150 min or more of moderate-vigorous physical activity (MVPA) were considered "physically active" whereas those that fell below this threshold were classified as "inactive", according to global recommendations for sufficient levels of physical activity [28].

2.5. Possible cofounders – personal information, anthropometry, and social isolation status

The following personal/demographic information were collected: (a) Sex; (b) Age (years); (c) Education level (elementary school; high school; college; and, postgraduate); (d) Anthropometric variables were assessed by self-report of weight (kg) and height (m), and body mass index (BMI) was calculated by dividing body weight by height squared (kg/m^2); and, (e) An open-ended question asked, "How long have you experienced social isolation?", as previously reported [20,22–24].

2.6. Statistical analysis

Data normality was verified using the Shapiro–Wilk test. Parametric variables were presented as mean and standard deviation and non-parametric variables as median and interquartile range. Comparisons between participants' sociodemographic variables, food habits, and MVPA among those identified as non-anxious and anxious were performed using the t-test for independent samples (parametric data) or Mann–Whitney test (non-parametric data). The relationship between anxiety and eating habits according to levels of physical activity (inactive vs. active) was analyzed using binary logistic regression adjusted for sex, age, education level, and social isolation. Statistical significance was established at 5% and a 95% confidence interval (95%CI). Analyses were performed using the e Statistical Package for Social Sciences (SPSS) v. 15.0 (IBM, Armonk, NY).

3. Results

3.1. Comparison analysis

The sample consisted of 1826 adults with an average age of 38.2 ± 13.0 years, among which 1068 were women (58.5%). The proportions of educational level attained in the sample was 0.3% for elementary school (n = 5), 8.2% for high school (n = 149), 42.6% for college (n = 777), and 49.0% for postgraduate (n = 895). Approximately 35.8% (n = 654) of those surveyed reported they were unemployed at the time of the survey.

Additionally, 30.8% (n = 562) were identified as anxious and 28.5% (n = 520) were determined to be physically active. When considering the joint association of anxiety and physical activity, the prevalence of anxiety was 27.7% (n = 144) among participants who were physically active and 32.1% (n = 418) among those considered inactive during the pandemic, with no significant difference between proportions (Chi-square, p = 0.068). Table 1 shows the sample characteristics according to anxiety. Participants who reported feeling no anxiety were older, consumed more fruits, vegetables and cereals, and practiced more MVPA when compared to participants who reported feeling anxious (p < 0.001). Adults with anxiety consumed more sweets, fried foods, and fast foods during the week.

3.2. Binary logistic regression

When analyzing the association of healthy eating habits with anxiety according to physical activity level, those participants who were anxious and physically inactive were 46% (Odds ratio = 0.54, p = 0.023) and 30% (Odds ratio = 0.70, p = 0.029) less likely to have regular consumption of vegetables and cereals, respectively (Table 2). However, after adjustment for BMI at Model 2, these relationships became marginally related (p = 0.057 for vegetables and p = 0.099 for cereals).

3.3. Binary logistic regression

Table 3 shows the relationship between unhealthy eating habits and anxiety according to physical activity level. Among physically inactive participants, anxiety was associated with high consumption of sweets (Odds ratio = 1.44, p = 0.004) and red meat (Odds ratio = 1.30, p = 0.049). Anxiety was also associated with increased consumption of fast foods in both inactive participants (Odds ratio = 2.34, p = 0.024) and active participants (Odds ratio = 4.27, p = 0.042). However, after adjustment of BMI in Model 2, only the relationship between anxiety and high consumption of sweets (Odds ratio = 1.43, p = 0.005) and fast foods (Odds ratio = 2.23, p = 0.037) in physically inactive participants remained significant.

4. Discussion

The main findings of the present study are as follows: 1) in physically inactive participants, anxiety was related to decreased vegetable and cereal consumption and increased consumption of sweets and red meat, and 2) among those that reported feeling anxious, they were more likely to consume fast food regularly regardless of physical activity levels. After adjustment for BMI, only the relationship of anxiety with sweets and fast foods in physically inactive participants remained significant.

Studies have shown that increases in stress, anxiety, depression, sleep disorders, denial, anger and fear have been impacting global health during the COVID-19 pandemic [29,30]. Those with anxiety and depression are more likely to engage in harmful behaviors such as suicide, self-harm, have an eating disorder, and abuse alcohol [11,31,32].

Our results revealed approximately 30% of the sample reported feeling anxiety during the pandemic. Similar results were reported by Moccia et al. [33], where 38% of Italian adults reported some type of psychological distress during the COVID-19 outbreak in Italy. A recent meta-analysis estimated an anxiety prevalence of 25% among the general population during the COVID-19 pandemic [34]. Pashazadeh Kan et al. [35] observed that the prevalence of anxiety was even higher among COVID-19 patients: 39.6% when compared with 27.3% from the general population. When considering the symptoms of anxiety, a pooled prevalence of 46% has been observed, without significant influence of age and sex [36].

We demonstrated that individuals that reported feeling anxious consumed less fruits and vegetables and were more likely to consume sweets and fast food regularly. This may be due to food insecurity, which is defined as an uncertain condition of access to nutritious and healthy foods for some time [37]. This finding could also be related to insecurity about the economic impairment of the COVID-19 pandemic within this study sample, where 35.8% of participants reported that they were unemployed at the time of the survey. Wolfson et al. [37] observed that U.S. adults with very low food security were six times more likely to experience anxiety. Similarly, impulsivity was related to higher consumption of sugar, total fat, and saturated fat intake among women with a generalized anxiety disorder [38]. Therefore, anxiety may be associated with the impulsive eating behaviors.

Table 1
General characteristics, anxiety and eating habits of Brazilians isolated during the COVID-19 pandemic (n = 1826).

	Not anxious (n = 1264)	Anxious (n = 563)	p-value
	Mean (SD) or Median (Min-Max)	Mean (SD) or Median (Min-Max)	
Age (yrs)	40.01 (13.72)	34.09 (10.21)	<0.001
Weight (kg)	72.00 (40.00–145.00)	69.00 (43.00–180.00)	0.057
Height (cm)	169.00 (1.44–1.98)	167.00 (1.48–2.00)	<0.001
Body mass index (kg/m^2)	25.00 (14.26–47.23)	25.09 (16.38–58.78)	0.670
Fruits (day/week)	5.00 (0.00–7.00)	5.00 (0.00–7.00)	<0.001
Vegetables (day/week)	5.00 (0.00–7.00)	5.00 (0.00–7.00)	<0.001
Cereals (day/week)	2.00 (0.00–7.00)	2.00 (0.00–7.00)	0.035
Grains (day/week)	6.00 (0.00–7.00)	6.00 (0.00–7.00)	0.427
Sweet (day/week)	3.00 (0.00–7.00)	4.00 (0.00–7.00)	<0.001
Fried food (day/week)	1.00 (0.00–7.00)	2.00 (0.00–7.00)	<0.001
Red meat (day/week)	3.00 (0.00–7.00)	4.00 (0.00–7.00)	0.080
Fast-food (day/week)	1.00 (0.00–7.00)	1.00 (0.00–7.00)	<0.001
MVPA (min/week)	90.00 (0.00–420.00)	60.00 (0.00–420.00)	<0.001

MVPA = moderate-vigorous physical activity; SD= Standard deviation. P ≤ 0.05.

Table 2
Relationship between anxiety and high consumption of vegetables, fruits, cereals and grains according to the levels of physical activity during the quarantine of COVID-19 (n = 1826).

	Vegetables				Fruits				Cereals				Grains			
	Model 1		Model 2		Model 1		Model 2		Model 1		Model 2		Model 1		Model 2	
	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI
Inactive																
Not anxious	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference
Anxious	**0.54**	**0.78–0.96**	0.78	0.61–1.00	0.84	0.65–1.09	0.89	0.69–1.15	**0.70**	**0.51–0.96**	0.76	0.55–1.05	0.86	0.64–1.16	0.86	0.63–1.16
Active																
Not anxious	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference
Anxious	0.76	0.47–1.20	0.78	0.49–1.25	0.72	0.48–1.09	0.76	0.50–1.16	0.68	0.43–1.06	0.69	0.44–1.08	0.83	0.52–1.30	0.89	056–1.41

OR: Odds ratio; CI: Confidence interval; Model 1: adjusted by sex, age, education level, and social isolation time; Model 2: variables of Model 1 + body mass index. Bold values were statistically significant at $p < 0.05$ level.

Table 3
Relationship between anxiety and high consumption of sweets, fried foods, read meat and fast-food according to the levels of physical activity during the quarantine of COVID-19.

	Sweets				Fried foods				Red Meat				Fast-food			
	Model 1		Model 2		Model 1		Model 2		Model 1		Model 2		Model 1		Model 2	
	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI
Inactive																
Not anxious	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference
Anxious	**1.44**	**1.12–1.84**	**1.43**	**1.11–1.83**	1.40	0.86–2.27	1.32	0.80–2.15	**1.30**	**1.00–1.69**	1.24	0.95–1.61	**2.35**	**1.12–4.99**	**2.23**	**1.05–4.74**
Active																
Not anxious	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference
Anxious	1.28	0.84–1.93	1.32	0.87–2.00	1.10	0.40–3.03	1.05	0.37–2.93	0.91	0.57–1.44	0.86	0.54–1.37	**4.27**	**1.05–17.31**	3.99	0.97–16.39

OR: Odds ratio; CI: Confidence interval; Model 1: adjusted by sex, age, education level, and social isolation time; Model 2: variables of Model 1 + body mass index. Bold values were statistically significant at $p < 0.05$ level.

Exercise is associated with wellbeing, mood and mental health, such as depression and anxiety [39]. It has been demonstrated that regular exercise performed for at least 10 weeks (at least 30 min a day, three to four times a week) can effectively reduce anxiety levels [40].

We observed an association between anxiety and altered eating habits among active and inactive participants. Current WHO recommendations cite the importance of maintaining physical activity during the COVID-19 pandemic [41]. A study compared high-intensity and moderate-intensity training in 67 healthy Spanish adults during 6 weeks of COVID-19 confinement and discovered both modes of exercise were effective in decreasing anxiety [42]. It is important to highlight we did not measure participants' level of physical activity, yettype of exercise and intensity can directly influence an increase or decrease in reported anxiety levels. Meira et al. [43] observed that leisure-time physical activity was inversely associated with anxiety in adults regardless of gender, age, and education. These findings are similar to a study performed among Korean adults, where those that were identified as physical active experienced reduced anxiety levels [44].

The relationship between physical activity and reduced feelings of anxiety may be explained by induced amygdala reactivity which results in an anxiolytic effect [45]. Physical activity also maintains cardiac autonomic modulation, which could contribute to the reduction of sympathetic activity and successive episodes of anxiety [46]. Lopez-Bueno et al. [14] found that Spanish adults who performed 150 minutes of moderate to vigorous physical activity were less likely to experience anxiety when quarantined during COVID-19.

Studies conducted prior to the COVID-19 pandemic reported that adults with higher levels of physical activity were more likely to have healthier eating habits [17–19]. During the pandemic, Christofaro et al. [20] observed that regular physical activity was associated with better eating habits in adults. Whereas time spent participating in sedentary behaviors has been associated with the consumption of sweets and ultra-processed foods [22,47].

A possible explanation for this association is that physically active participants may be concerned about their health in general, which may contribute to healthier eating behaviors [18,19]. Otherwise, studies also reported that fast food consumption has increased during the COVID-19 pandemic [21,48]. However, to our knowledge, no previous study has analyzed the relationship between anxiety and eating habits according to physical activity level in an adult population during the COVID-19 pandemic, precluding further comparisons.

In addition to physical activity, the maintenance of healthy eating habits during the pandemic may attenuate several health impairments associated with poor eating habits, such as weight gain caused by a consistent, positive energy balance due to the regular consumption of high-calorie foods [48], which may lead to obesity and higher cardiometabolic risks [49,50], which may in turn impact morbidity and mortality [51]. Poor eating habits have also been associated with malnutrition and may lead to a lower immunological response [52,53], which may increase susceptibility to illness – an important concern during the COVID-19 pandemic [54].

It is important to highlight that BMI was a confounding factor in the present findings. The relationship between anxiety and consumption of vegetables and cereals, as well as red meat, were mitigated after considering BMI. Di Filippo et al. [55] observed that COVID-19 patients with overweight and obesity experienced rapid weight gain after hospital discharge, suggesting that these individuals are at a higher risk of poor eating and lifestyle habits during their recovery. Robinson et al. [56] observed that adults with a higher BMI were more likely to report overeating and experience negative changes in eating quality and physical activity during the

pandemic. In this sense, strategies for health promotion through healthy habits and mental health need to be focused on overweight and obese adults, since this population have presented eating disorders, substantial reduction in physical activity levels, and increased anxiety during the COVID-19 pandemic [57].

The current study has some limitations. Its cross-sectional design prevents any assumption of cause and effect, and recall bias could affect the results. Another limitation is the absence of a measure of the actual quantities of foods consumed during the week (e.g., number of servings per day of fruits, vegetables, cereals, etc.), which precluded daily caloric intake estimation. Additionally, anxiety levels were self-reported and the questionnaire was not a diagnostic tool. The use of non-validated questionnaires to assess anxiety levels and the lack of information about mental health status for participants prior to stay-at-home orders are potential limitations, as well. Additionally, social biases could have also influenced participants' responses. Given the questionnaire was distributed online, sample selection was limited to only those with access to technological devices and the internet. Additionally, data collection was limited to two weeks. Study strengths include a large sample size and the innovative findings.

In conclusion, anxiety was associated with reduced diet quality among physically inactive adults during the COVID-19 pandemic. Given this association, public health messaging may need to include language regarding the importance of greater adherence to healthy dietary habits, as well as the beginning and maintenance of regular physical activity during the COVID-19 pandemic.

Author's contribution

DGDC: Conceptualization; Formal analysis; Writing – original draft;

WRT: Methodology; Writing – original draft GCR: Methodology; Writing – original draft.

MCLP: Data curation; Project administration Joao Paulo Botero: Resources; Writing – review & editing.

GGC: Resources; Writing – review & editing.

NM: Conceptualization; Investigation; Writing – review & editing.

KR: Data curation; Visualization.

MC: Conceptualization; Data curation; Project administration.

RMRD: Data curation; Methodology; Supervision; Writing – review & editing.

WLP: Data curation; Methodology; Supervision; Writing – review & editing.

Declaration of competing interest

None to declare.

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