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Association of depression and anxiety symptoms with exercise in Brazil: a cross-sectional study

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Association of depression and anxiety symptoms with exercise in Brazil: a cross-sectional study

Running title: Mental ill-health symptoms and exercise in Rio

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Abstract

Objective: This study aimed to investigate the relationship between the frequency and duration of exercise and symptoms of depression and anxiety.

Methods: This is a household survey conducted with a sample of 2,297 adults living in the city of Rio de Janeiro. The frequency and duration of exercise were measured using two closed-ended questions. Symptoms of depression and anxiety were assessed using the PHQ-9 and the GAD-7, respectively. Additionally, sociodemographic and anthropometric information (weight and height) was obtained. Bivariate and multivariate regression models were used to estimate the odds ratios (OR) of the associations between the variables.

Results: A total of 2,201 (age= 38.3 years (SE = 0.4), 62% women) individuals were evaluated. Compared to the non-exercisers, individuals who exercised at least once a week showed significantly lower odds of presenting depressive symptoms, even after adjusting for sex and BMI (OR = 0.7 [95% CI: 0.50–0.96], $p = 0.03$). Similar results were observed for frequency (2-4 times per week) and duration (≥1 hour and <2 hours). However, after adjusting for sex and BMI, these associations were no longer significant. Finally, no association was found between exercise and anxiety symptoms.

Conclusion: Physical exercise was associated with a lower likelihood of presenting depressive symptoms. Additionally, a moderate frequency and duration of exercise, initially associated with reduced odds of depressive symptoms, was no longer significant after adjusting for sex and BMI. Thus, body weight and sex appear to mediate the relationship between physical exercise and depressive symptoms in our sample.

Keywords: Exercise, mental health, depression, anxiety.

Introduction

Approximately 1 billion people worldwide live with a mental disorder, and, of note, 82% of these cases occur in low- and middle-income countries[1]. Recent data indicate that mental disorders, particularly depression and anxiety, are among the leading contributors to the Global Burden of Disease (GBD)[2]. The prevalence of depressive disorders is estimated at 4.4%, while anxiety disorders affect 3.6% of the global population[3]. Brazil ranks as the fifth country with the highest prevalence of depression and has the highest global prevalence of anxiety, affecting approximately 5.8% and 9.3% of the population, respectively[3].

Lifestyle factors, such as high physical activity levels, healthy diet habits, and adequate sleep, improve mental health and reduce the risk of mental disorders[4]. A meta-analysis by Wang et al (2021) showed that individuals with the healthiest lifestyle had an approximately 50% lower risk of having depressive symptoms compared to individuals with an unhealthy lifestyle[5]. Specifically, the role of physical activity has been widely investigated, and several evidence have shown that it has a protective effect against both depression and anxiety[6–9]. A recent meta-review found that higher physical activity levels are protective against the risk of developing depression (OR = 0.85, 95% CI: 0.81-0.89) and anxiety (OR = 0.86, 95% CI: 0.69-0.99)[4]. The European Psychiatric Association (EPA) has even published guidelines recommending exercise as a treatment for depression and as a complementary intervention for serious mental illnesses[10].

Remarkably, the effect of exercise, the structured subset of physical activity, on symptoms of depression and anxiety appears to be modulated by the level of intensity. A meta-analysis by Noetel et al. (2024)[9] showed that the benefits of exercise tend to be proportionally related to intensity, with vigorous activity

being the most effective. Although light physical activity still demonstrated clinically significant effects (g = -0.58, -0.82 to -0.33), the observed effects were stronger for vigorous exercises (g = -0.74, -1.10 to -0.38)[9]. Another recent meta-analysis by Pearce et al. (2022)[8] identified an 18% (95% CI: 13%-23%) reduction in the incidence risk of depression among individuals who engaged in half of the World Health Organization's recommended weekly volume of physical activity, compared to sedentary individuals. Nevertheless, there is a lack of evidence further exploring the frequency and duration of regular exercise required to reduce the risk of depression and anxiety. Furthermore, there are a limited number of studies conducted in middle-income countries that examine the association between exercise and these symptoms.

In this context, this study aimed to evaluate the association between physical activity and mental health in adults. Specifically, the study investigated the relationship between the frequency and duration of exercise and symptoms of depression and anxiety.

Methods

Participants

This study utilized data from *Binge Eating in Rio[11],* conducted in Rio de Janeiro, the second-largest city in Brazil [Brazilian Institute of Geography and Statistics – *Instituto Brasileiro de Geografia e Estatística (IBGE)*][12]. The study consisted of an in-person household survey involving non-institutionalized adult residents (18 to 60 years old). Exclusion criteria included pregnant and breastfeeding women. The research employed a stratified and clustered

probabilistic sample, selected in three stages: census enumeration areas (CEAs), households, and eligible adults.[11]

Procedures

The study was conducted between September 2019 and February 2020. Of the 2,985 eligible households, 2,297 agreed to participate. Trained interviewers invited participants to complete a questionnaire on a tablet; height and weight measurements were also taken on-site. For the current study, 96 individuals were excluded for missing exercise data, resulting in a final sample of 2,201 participants. For more details, see Appolinario et al. (2022)[11].

Measures

Sociodemographics

Sociodemographic data collected included self-reported gender, self-reported race/ethnicity, age, marital status, educational level, employment status, and income.

Exercise

The assessment of exercise was conducted using the following closed-ended questions:

1) "How often, in the last three months, have you practiced any kind of physical exercise or sport?" with the following possible answers. (a) I

do not engage in physical activity, (b) 1 to 3 times per month, (c) once a week, (d) 2 to 4 times per week, (e) 5 to 6 times per week, (f) daily.

2) "In general, on the day that you practice exercise or sports, how long does this activity last?" with the following possible answers. (a) Up to 30 minutes per day, (b) between 30 minutes and less than 1 hour, (c) between 1 hour and less than 2 hours, (d) 2 hours or more.

Individuals were classified as "exerciser" if they reported engaging in exercise at least once per week, regardless of duration. Conversely, individuals who reported not engaging in exercise or exercising less than once per week, regardless of duration, were classified as "non-exerciser".

Mental Health parameters

For the assessment of mental health symptoms, the Brazilian version of the Patient Health Questionnaire-9 (PHQ-9) was used, a self-reported depressive symptom evaluation tool. The PHQ-9 is a multiple-choice questionnaire consisting of nine items, based on the diagnostic criteria for major depression from the DSM-IV. Depression was defined as a PHQ-9 score of ≥10, which indicates the presence of clinically significant depressive symptoms[13,14]. The Generalized Anxiety Disorder-7 (GAD-7), a validated instrument in Brazil, was utilized for anxiety assessment. The GAD-7, composed of 7 items, is designed to identify potential cases of anxiety and assess the severity of symptoms. Generalized anxiety symptoms were defined by a cutoff score of ≥8[15,16].

Anthropometric parameters

Weight was measured using a digital scale with a maximum capacity of 150 kg and a precision of 100 g (Plenna®, São Paulo, Brazil). Individuals were weighed at the site, barefoot, wearing light clothing, and positioned at the center of the scale, with their arms hanging freely by their sides. Height measurement was performed using a portable stadiometer with a maximum capacity of 200 cm and a precision of 0.1 cm (model 206; Seca®, Hamburg, Germany). Body Mass Index (BMI) was calculated and classified into the following categories: underweight (<18.5 kg/m²), normal weight (18.5 kg/m²–24.9 kg/m²), overweight (25 kg/m²–29.9 kg/m²), and obese (≥30 kg/m²).

Statistical analysis

First, we described data from all participants' responses. The means of age and BMI and weighted frequencies of sociodemographic characteristics, BMI, depression, and anxiety were estimated. Subsequently, participants were categorized into two groups based on their level of exercise. The weighted frequencies of psychiatric symptoms were calculated according to the frequency and duration of exercise. Between-group differences were statistically compared using the Wald chi-square test (categorical variables) and the T-test (continuous variables). Bivariate and multiple regression models were used to estimate the odds ratios of the associations between exercise (practice, frequency and duration) and mental health-related outcomes. Sex and BMI categories were used as potential confounders. All statistical analyses were estimated, considering the weights and the complex survey design, using the Proc Survey procedures in the Statistical Analysis System (SAS) (release 9.5).

Results

Of the 2,201 participants, approximately 62% were female, 39.8% self-reported as white race/ethnicity, and the mean age of the sample was 38.3 years (SE = 0.4). The majority (43%) had between 11 and 14 years of schooling, and 39.6% had a monthly income between R$1,001.00 and R$3,000.00 (equivalent to 1 to 2.5 Brazilian minimum wages). The mean BMI of the total sample was 27.7 (SE = 0.2), 62.6% had a higher BMI (37.1% classified in the range of overweight, and 28.3% in the range of obesity) (Table 1).

Table 1 – Weighted frequencies of sociodemographic and metabolic characteristics according to the practice of exercise.

	non-exercisers (n=1441)			exercisers* (n=760)			P
	n	%	95%CI	n	%	95%CI	
Overall	1441	64.9	61.7-68.0	760	35.1	32.0-38.3	-
Sex							
Male	**500**	**42.9**	**39.5-46.3**	**328**	**54.8**	**49.9-59.7**	**<.0001**
Female	**941**	**57.1**	**53.7-60.5**	**432**	**45.2**	**40.3-50.1**	
Race/ethnicity							
White	549	36.1	32.3-39.8	327	40.1	34.6-45.6	0.44
Black	263	20.6	17.9-23.4	126	19.0	13.9-24.1	
Mixed[a]	629	43.3	39.7-46.9	307	40.9	35.0-46.8	
Age [M (SE)]	39.0 (0.5)		37.9-40.1	37.1 (0.6)		35.8-38.3	**0.009**
Age groups							
18-30 years	326	29.6	25.2-33.9	211	36.3	31.7-41.0	0.08
31-45 years	494	37.3	33.7-40.9	272	34.6	29.6-39.6	
46-60 years	621	33.1	29.3-36.9	277	29.1	24.6-33.4	
Marital status							
Single	518	34.2	28.9-39.4	302	39.0	33.8-44.1	0.38
Married	694	55.4	50.4-60.4	366	51.7	46.4-57.0	
Widow or divorced	229	10.4	8.5-12.3	92	9.3	7.1-11.5	
Schooling[b]							
0-10 years	**638**	**43.2**	**36.7-49.6**	**193**	**25.9**	**19.8-32.1**	**<.0001**
11-14 years	**601**	**44.6**	**39.0-50.3**	**345**	**48.2**	**42.5-53.9**	
>15 years	**202**	**12.2**	**9.7-14.7**	**222**	**25.9**	**20.4-31.3**	
Income[c]							
Up to R$1.000.00	**378**	**27.0**	**20.9-33.1**	**110**	**18.0**	**13.7-22.2**	**0.0002**

	N	%	95% CI	N	%	95% CI	
R$1.001.00-R$3.000.00	**592**	**51.0**	**45.3-56.8**	**279**	**49.0**	**41.7-56.4**	
>R$3.000.00	**251**	**22.0**	**17.3-26.5**	**205**	**33.0**	**26.0-40.0**	
Main occupation							
Employed	908	63.1	59.2-67.0	476	63.3	59.1-67.4	0.95
Unemployed, student or retired	533	36.9	33.0-40.7	284	36.7	32.6-40.9	
BMI *[M (SE)]*	**28.3 (0.2)**		**27.8-28.8**	**26.6 (0.3)**		**26.1-27.2**	**<.0001**
BMI categories							
Under/Normal weight	**427**	**31.5**	**27.6-35.3**	**284**	**40.3**	**35.7-44.9**	**0.0001**
Overweight/obesity	**936**	**68.5**	**64.7-72.4**	**441**	**59.7**	**55.1-64.3**	

Note: Wald chi-square test; *M:* Mean; *SE*: Standard error; *Practiced exercise at least once a week; [a] Mixed: Brown, Yellow, and Indigenous; [b] Schooling = 0–10 years (equivalent to elementary), 11–14 years (equivalent to high school), > 15 years of study (college or above); [c] Income = R$1000.00 is approximately one minimum wage in Brazil.

Table 2- Weighted frequencies and odds ratio of mental health symptoms according to the practice of exercise.

Mental health symptoms	non-exercisers (n=1441)		exercisers* (n=760)							
	N	%	N	%	OR	95% CI	p	Adjusted OR[#]	95% CI	P
Depression	**201**	**13.1**	**67**	**7.9**	**0.57**	**0.42-0.77**	**0.0004**	**0.69**	**0.50-0.96**	**0.03**
Anxiety	203	12.6	80	10.6	0.82	0.52-1.31	0.41	1.01	0.65-1.57	0.96

Note: *Practiced exercise at least once a week; Wald chi-square test; [#]Adjusted for sex and BMI.

In terms of mental health, 11.3% (95% CI: 8.6-13.9) of the sample displayed depressive symptoms – 5.5% (95% CI: 3.2-8.3) among men and 16.2% (95% CI: 11.9-20.5) among women. On the same path, 11.9% (95% CI: 9.4-14.4) of the sample showed symptoms of anxiety, with a prevalence of 6.5% (95% CI: 3.7-9.3) among men and 16.7% (95% CI: 11.3-22.1) among women. A total of 35.1% of the samples were engaged in regular exercise (Table 1). Individuals who exercised between 2 and 4 times per week represented 16.4% (95% CI: 14.1-18.7) of exercisers, while 15.2% (95% CI: 13.1-17.3) reported exercise between 1 hour and less than 2 hours (Tables 3 and 4).

Table 3- Weighted frequencies and odds ratio of mental health symptoms according to the frequency of exercise.

Mental health symptoms	Frequency of exercise																
	Not practiced (n=1441)		Once a week (n=96)					2-4 times/week (n=365)					≥5 times/week (n=299)				
	N	%	N	%	OR	95% CI	p	N	%	OR	95% CI	p	N	%	OR	95% CI	p
Depression (unadjusted analysis)	201	13.1	12	6.9	0.49	0.22-1.10	0.08	**28**	**7.7**	**0.55**	**0.35-0.87**	**0.01***| 27	8.5	0.62	0.37-1.02	0.06
Depression (adjusted analysis)*								**28**	**7.7**	**0.65**	**0.41-1.04**	**0.07**					
Anxiety (unadjusted analysis)	203	12.6	12	9.8	0.75	0.29-1.92	0.55	33	10.9	0.85	0.54-1.33	0.48	35	10.6	0.82	0.46-1.47	0.50
Anxiety (adjusted analysis)*																	

Note: Wald chi-square test; *Controlled for sex and BMI.

Table 4- Weighted frequencies and odds ratio of mental health symptoms according to the duration of exercise.

Mental health symptoms	Duration of exercise																					
	Not practiced (n=1441)		<30 minutes (n=50)					≥30 minutes and <1 hour (n=344)					≥1 hour and <2 hours (n=313)					≥2 hours (n=53)				
	N	%	N	%	OR	95% CI	p	N	%	OR	95% CI	p	N	%	OR	95% CI	p	N	%	OR	95% CI	p
Depression (unadjusted analysis)	201	13.1	5	4.9	0.34	0.10-1.13	0.079	31	8.7	0.63	0.39-1.03	0.067	**27**	**8**	**0.57**	**0.36-0.90**	**0.017***	4	5.5	0.38	0.11-1.35	0.13
Depression (adjusted analysis)*													**27**	**8**	**0.71**	**0.43-1.16**	**0.17**					
Anxiety (unadjusted analysis)	203	12.6	6	11	0.85	0.18-3.92	0.84	31	12	0.94	0.51-1.72	0.84	37	9.5	0.73	0.44-1.19	0.20	6	9.1	0.69	0.28-1.71	0.42
Anxiety (adjusted analysis)*																						

Note: Wald chi-square test; * Controlled for sex and BMI.

Exercisers had significantly lower odds of depressive symptoms (OR = 0.57 [95%CI: 0.42–0.77], p = 0.0004) compared to the non-exercisers, and these results remained consistent even after adjustment for sex and BMI (OR = 0.69 [95% CI: 0.50–0.96], p = 0.03). We did not find any associations between exercise and anxiety symptoms (Table 2). In a further analysis, we analyzed the association of the frequency and duration of exercise with depression and anxiety. For depressive symptoms, only individuals who engaged in exercise 2-4 times per week had lower odds of depressive symptoms than the sedentary group (OR = 0.55 [95%CI: 0.35–0.87], p = 0.01) (Table 3). When assessing the duration of each exercise session, only individuals who exercised between ≥1 and <2 hours had lower odds of depressive symptoms (OR = 0.57 [95%CI: 0.36–0.90], p = 0.02) (Table 4). However, after adjustment for sex and BMI, these associations were no longer significant (Tables 3 and 4). No association was found between the weekly frequency and duration of exercise and the prevalence of anxiety symptoms (Tables 3 and 4).

Discussion

This study investigated the association between the frequency and duration of exercise and mental health in the general population of Rio de Janeiro, Brazil. We found that exercise was inversely associated with depressive symptoms. More specifically, exercisers had a 30% lower likelihood of experiencing depressive symptoms compared to the non-exercisers. When analyzing exercise frequency and duration, a reduction in depressive symptoms was observed among individuals who exercised 2 to 4 times per week and those who exercised ≥1 hour and <2 hours per day. Nevertheless, these results were

no longer statistically significant after adjustment for sex and body mass index (BMI). It was also found that two-thirds of the sample did not engage in regular exercise. Overall, our findings are consistent with the literature and provide important additional insights about the relationship between physical activity and depression symptoms in the general population of a middle-income country, which remains an understudied group. Additionally, we did not find an association between exercise and anxiety symptoms. This finding is not entirely inconsistent with the literature, as there is a smaller body of evidence regarding the association between physical activity and anxiety compared to depression[4].

The inverse association between physical activity and the prevalence of depressive symptoms observed in our sample has also been reported in other studies. Pearce et al. (2022)[8] reported that individuals who engage in regular physical activity have a 25% lower risk of developing depression. The same study showed that performing half of the recommended weekly volume was associated with an 18% reduction in risk compared to sedentary individuals. Another meta-analysis[6], including 49 studies, found that individuals with high levels of physical activity had approximately 20% lower odds of developing future depression compared to those with low levels of physical activity. The protective effects were observed regardless of age and sex. Recently, Zhang et al (2025)[17] found that individuals with moderate and high volumes of physical activity were associated with a lower risk of depressive symptoms compared to those with low volumes of physical activity.

We found no association between physical activity and anxiety, even though the behavior regarding frequency and duration of physical activity in this group was like that observed among individuals with depressive symptoms.

Although both, acute and chronic anxiolytic effects of exercise are well documented, a recent meta-review[4] on lifestyle's protective role in mental disorders highlights the limitations in the area, mostly related to the small number of available studies and the heterogeneity across meta-analyses on the knowledge of physical activity and anxiety. McDowell et al. (2019)[18], in their meta-analysis, reported that individuals who engaged in physical activity had approximately 13% lower odds of presenting anxiety symptoms. However, only 4 out of 15 studies showed significant associations between physical activity and anxiety symptoms. Moreover, the authors reported insufficient data to quantitatively assess a dose-response of this relationship[18].

Although the benefits are widely demonstrated[4], the mechanisms by which exercise exerts its antidepressant effects are not fully understood. Regarding neurobiological mechanisms, the literature shows that exercise increases levels of neurotransmitters (e.g., endorphins, serotonin, and dopamine)[19] as well as brain-derived neurotrophic factor[20]. Meanwhile, regarding psychosocial mechanisms, evidence suggests that physical exercise promotes increases in self-esteem, self-efficacy, and self-concept[21].

This study has some limitations. First, its cross-sectional design does not allow for determining the directionality of the relationship between exercise and mental disorders, nor for establishing causality. Second, the exercise questionnaire was composed of only two closed-ended questions, which limits the accuracy of measuring both the frequency and duration of exercise. It was also not possible to assess the type or intensity of the activity. Lastly, mental health parameters were assessed solely through screening instruments, which

are subject to memory and social desirability biases, which may have led to false positives or negatives.

Our study presents several strengths. First, it includes a large sample from a middle-income population in the sixth-largest city in the Americas. Second, the study design employed random sampling, capturing participants from diverse socioeconomic backgrounds within a major metropolitan area. Third, we used validated psychometric instruments to assess depressive and anxiety symptoms. Fourth, regression models were used to analyze the associations between exercise and depressive and anxiety symptoms, while controlling for potential confounding factors such as higher BMI and sex. In the future, longitudinal studies could address causal relationships between exercise and mental health, for example, by using objective measures of physical activity (e.g., accelerometers) and investigating the role of exercise type and intensity in these associations.

Conclusion

Physical exercise was associated with a lower likelihood of exhibiting depressive symptoms. Although moderate frequency and duration of exercise were linked to reduced odds of depressive symptoms, this association was no longer significant after adjusting for confounding variables. These findings suggest that body weight and sex may mediate the relationship between physical exercise and depressive symptoms in our sample. Additionally, no association was found between physical exercise and the prevalence of anxiety symptoms.

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