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Effects of aerobic and strength training on depression, anxiety, and health self-perception levels during the COVID-19 pandemic

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Abstract. – OBJECTIVE: This study aimed at comparing the depression and anxiety levels, and health self-perception during the coronavirus disease 2019 pandemic among subjects who practice aerobic, strength, and mixed (aerobic and strength) exercises and nonsports participants.

MATERIALS AND METHODS: We included 304 Brazilians of both sexes in this cross-sectional study. All participants were recruited through online advertisement and completed a self-administered questionnaire regarding the personal information, level of restriction adopted, physical activity, and mood state screening (Patient Health Questionnaire-9 and General Anxiety Disorder-7). We divided the participants into four groups: strength sports group (CrossFit or strength training), aerobic/endurance sports groups (running, cycling, triathlon, or swimming), mixed sports groups (individuals who practice endurance and strength sports), and nonsports group.

RESULTS: The Kruskal-Wallis test showed a significant effect of the group on the depression and anxiety levels. Meanwhile, the post-hoc comparisons showed a significantly lower depression level in the mixed and aerobic sports groups than in the strength sports and nonsports groups, and a significantly lower anxiety level in the mixed and aerobic sports groups than in the nonsports group. Furthermore, participants in the mixed, strength, and aerobic sports groups presented a better level of health self-assessment than the nonsports group, and those in the mixed sports group had a better level of health self-assessment than the strength or aerobic sports groups.

CONCLUSIONS: Individuals practicing aerobic exercises present lower depression and anxiety levels than those practicing strength training and are inactive. However, individuals who practice strength exercises and aerobics have the best levels of health perception.

Key Words:
Anxiety, COVID-19, Depression, Endurance, Exercise, Strength.

Introduction

The coronavirus disease 2019 (COVID-19), caused by the Severe Acute Respiratory Syndrome Coronavirus 2, was declared a pandemic by the World Health Organization on March 11, 2020[1]. Previous studies[2-9] have extensively showed the several negative consequences of the COVID-19 pandemic, among which is the negative impact on mental health, particularly the incidence of depression and anxiety symptoms. Before the pandemic, depression and anxiety were the most prevalent mental health conditions in the world, reaching 4.4% and 3.6% in 2017, respectively[10]. In 2020, during the pandemic, the prevalence of anxiety and depression increased significantly even among uninfected people and reached 32.9% and 33.7%, respectively[11]. Therefore, the pandemic causes physical and mental concerns for those infected, and also results in several psychological disorders in the entire pop-

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ulation[11-13]. Previous studies[2-4,7,9,12] have proposed several factors leading to this scenario, including fear of getting infected, infection of loved ones, social distancing measures to avoid the virus spread, excessive exposure to bad news from the media, and low and decreased physical activity levels.

Pharmacotherapy and psychotherapy are generally prescribed to patients with depression and anxiety[14-16]. However, both therapies tend to have small-to-modest effects[17,18]. Additionally, one-third of people with depression remain nonresponsive to treatment[19].

In this context, physical activity plays an important role because its beneficial effects on depression and anxiety symptoms are effective, safe, low-cost, feasible, and readily available[20-24]. Additionally, owing to its psychological effects, physical activity has been considered as a psychoactive drug[20]. Moreover, physical activity has also been shown to improve health self-perception[25,26], which is an important indicator related to morbidity, mortality, longevity, and health status[27].

Several studies[16,20,24,28,29] have shown the efficacy of exercises on depression and anxiety and found varying physiological mechanisms that explain the mental health improvement due to aerobic and strength exercises. Aerobic exercises produce similar neurophysiological effects to those observed from antidepressant drugs[30]. Some of these possible mechanisms are associated with neuroplasticity, neuroendocrine response, inflammation, and oxidative stress[16]. On the other hand, strength exercises can produce positive effects on mental health by improving muscular strength, functional capabilities, self-esteem, social support, and self-efficacy[16,28]. Research[31,32] has shown that muscle strength and cardiorespiratory fitness have an inverse relation with depressive symptoms, however, the exact physiological mechanisms and the effectiveness of each kind of exercise (aerobic or strength) are uncertain[23,29]. The effects of aerobic and strength training on mental health are difficult to compare because most studies were carried out only with aerobic exercise and the results of studies on strength exercises are contradictory[33-35].

The present study aimed to compare depression and anxiety levels and health self-perception of subjects who practice aerobic, strength, and mixed (aerobic and strength) exercises and nonsports subjects during the COVID-19 pandemic. We hypothesized that individuals practicing mixed exercises would present lower levels of depression and anxiety and a higher level of health self-perception because of the aerobic and strength exercises.

Materials and Methods

Participants

Participants were invited to the study through email and social media (Instagram, Facebook, and WhatsApp) accounts of the researchers and institutions involved. We shared the invitation containing a link to the questionnaire through Google Forms. No incentives were used in this survey. We included participants who were literate, over 18 years of age, and familiar with online questionnaires. Participants who did not complete the questionnaire were excluded from the survey. A total of 317 participants voluntarily answered the questionnaires, but 13 responses were excluded because they were incomplete. Therefore, a total of 304 responses were analyzed (from 131 women and 173 men). The participants were divided into four groups: strength sports group (CrossFit or strength training), aerobic/long-term endurance sports groups (running, cycling, triathlon, or swimming), mixed sports groups (individuals who practiced endurance and strength sports or collective sports, such as soccer, handball, or volleyball), and nonsports group.

Before answering the survey, the participants read and signed the informed written consent. The study was approved by the Human Research Ethics Committee of the Federal University of São Paulo (UNIFESP) (approval number: 4.073.442) and conformed to the principles outlined in the Declaration of Helsinki.

Study Design

This was a cross-sectional study based on structured questionnaires shared through Google Forms and collected from July 01 to 15, 2021. During the survey, the Brazilian government adopted flexibilization measures in the reopening of nonessential services with some restrictions, such as reduced hours and limited number of people in functional areas, such as restaurants, gyms, clubs, and parks. The self-administered questionnaires contained three sessions described below.

Questionnaire

The first session covered the participants' general information including sex (men or women), age (open-ended question), body mass (open-ended question), height (open-ended question), country and/or region of residence (open-ended question), education level (incomplete elementary school, complete elementary school, incomplete high school, complete high school, incomplete higher education, complete higher education, incomplete master's or doctorate, complete master's or doctorate), and working hours per day (open-ended question). For the purpose of analysis, we assigned scores from 0 to 7 to educational level, where 0 referred to the lowest level of education (elementary school incomplete) and 7 to the highest (complete master's or doctorate).

The second section contained multiple-choice questions related to behavior during the quarantine, the level of restriction adopted (total restriction without leaving home; partial restriction, leaving only for essential nonwork activities; leaving only for essential activities, including work activities; or minimal or no restriction), whether he or she engaged in any sport (yes or no), and if yes, which sport (open-ended question). For the purpose of analysis, we assigned scores from 1 to 4 to the restriction level, where 1 referred to the highest level of restriction (total restriction without leaving home) and 4 to the lowest (minimal or no restriction). Sports were grouped as follows: endurance, strength, and mixed sports or nonsports, according to the main characteristic of the sport modality. This section also contained a question regarding the self-perception of participants about their health (very bad, bad, good, very good, and excellent). For the purpose of analysis, we assigned scores from 1 to 5 to self-perception of health, where 1 referred to very bad and 5 to excellent. The participants also shared their current physical activity level. To this end, we used the international physical activity questionnaire (IPAQ)[36] which has acceptable measurement properties for estimating physical activity[36] and was validated for the Brazilian Portuguese language[37,38]. We classified the level of physical activity into five categories: very active (vigorous activities 5 days/week and ≥30 min per session, or vigorous activities ≥3 days/week and ≥20 min per session + moderate activities ≥5 days/week and ≥30 min per session), active (vigorous activities ≥3 days/week and ≥20 min per session, or moderate activities ≥5 days/week and ≥30 min per session, or any combined activities ≥5 days/week and ≥150 min/week such as walking + moderate + vigorous), irregularly active A (physical activities that could not be classified as active because they do not comply with the recommendations regarding frequency or duration), irregularly active B (physical activities that could not be classified as irregularly active A because they do not comply with either the frequency or duration recommendations), and not active (no physical activities that last 10 continuous minutes during the week)[38]. For the purpose of analysis, we assigned scores from 0 to 4 to activity levels, where 0 referred to the lowest level of activity (not active) and 4 to the highest (very active).

The third session screened for possible mood disorders. We used the Patient Health Questionnaire-9 (PHQ-9) and General Anxiety Disorder-7 (GAD-7) questionnaires. The PHQ-9 is a widely used instrument to identify individuals at risk of depression validated for Brazilian Portuguese[39,40]. The questionnaire provides a final score ranging from 0 to 27. A score ≤4 suggest minimal depression; from 5 to 9 mild depression; from 10 to 14 moderate depression; from 15 to 19 moderately severe depression; and ≥20 severe depression. For the purpose of analysis, we assigned scores from 0 to 4 to the levels of depression, where 0 referred to the lowest level of depression (minimal depression) and 4 to the highest (severe depression). The GAD-7 identifies possible generalized anxiety disorders and was validated for Brazilian Portuguese[41,42]. The questionnaire provides a final score ranging from 0 to 21. A score ≤4 suggests no anxiety disorder; from 5 to 9 mild anxiety; from 10 to 14 moderate anxiety; and ≥15 severe anxiety disorder. For the purpose of analysis, we assigned scores from 0 to 3 to the anxiety levels, where 0 referred to the lowest level of anxiety (no anxiety disorder) and 3 to the highest (severe anxiety disorder).

Statistical Analysis

The Kolmogorov-Smirnov test showed that only the age, body weight, and height had a normal distribution. Variables were expressed as median and interquartile ranges and categorical variables in absolute and/or relative frequencies. The one-way ANOVA test was used to verify differences in the age, body mass, and height. When necessary, the Tukey test was used as a post hoc test. Additionally, the χ^2 test was used to verify if the percentage of male and female participants were different in each group. The Kruskal-Wallis test was used to verify differences between groups according to restriction level, daily working hours, educational level, depression level, anxiety level, and self-perception of health. The Kruskal-Wallis test was complemented by post-hoc tests (pair-

Table I. Descriptive data about the participants.

	Strength sports (n = 142)	Endurance sports (n = 88)	Mixed sports (n = 48)	Nonsports (n = 26)	*p*-value
Age (years)	34.8 ± 7.8*	43.4 ± 9.6	36.3 ± 7.2*	39.3 ± 5.5	< 0.001
Body mass (kg)	75.4 ± 14.8	73.5 ± 13.4	75.5 ± 12.9	73.3 ± 16.3	0.70
Height (cm)	171.5 ± 10.2	173.2 ± 9.5	173.3 ± 7.2	170.6 ± 11.1	0.37

*$p < 0.05$ (different from endurance sports group).

wise analysis). Statistical analysis was performed using SPSS (version 21.0, IBM Corp., Armonk, NY, USA). In all comparisons, *p*-values <5% were considered statistically significant.

Results

Based on IPAQ, all the participants in the strength sports group, aerobic sports group, and mixed sports group were classified as active or very active, and all subjects in the nonsports group were classified as irregularly active or not active. Table I presents the descriptive data. The four groups presented similar values in body mass and height; however, the aerobic/endurance sports group were significantly older than those in the strength and mixed sports group.

There were no significant differences [χ^2 (3) = 7.515; $p = 0.06$] in the percentage of women and men in the mixed sports group (35.4% and 64.6%, respectively), strength sports groups (50.7% and 49.3%, respectively), endurance sports group (34.1% and 65.9%, respectively), and nonsports group (46.2% and 53.8%, respectively) [χ^2 (3) = 7.515; $p = 0.06$].

There were no significant difference between groups in the educational level, working hours per day, and restriction level (Table II).

Table III presents the percentage of each answer for the depression level, anxiety level, and health self-perception of each group.

The results of the Kruskal-Wallis test showed a significant effect in the depression level in the groups [χ^2 (3) = 16.69; $p < 0.001$]. Meanwhile, those of the post hoc comparisons showed a higher depression level for the nonsports group than for the endurance sports group ($p = 0.021$) and mixed sports group ($p = 0.003$), but not between the nonsports group and strength sports group ($p = 0.406$). Depression level was also higher in the strength sports group than in the mixed sports group ($p = 0.001$) and endurance sports group ($p = 0.013$). However, no significant differences were found between the endurance sports group and mixed sports group ($p = 0.228$) (Table IV).

The Kruskal-Wallis test showed a significant effect on the anxiety level evaluated through the GAD-7 questionnaire in the groups [χ^2 (3) = 9.671; $p < 0.022$]. The post-hoc comparisons showed a significantly higher anxiety level in the nonsports group than in the endurance sports group ($p = 0.038$) and mixed sports group ($p = 0.010$), but not the strength sports group ($p = 0.260$). The anxiety level in the strength sports group was higher than that in the mixed sports group ($p = 0.021$). However, we found similar anxiety levels between the endurance sports group and mixed sports group ($p = 0.367$) and between the endurance sports group and strength sports group ($p = 0.100$) (Table IV).

The Kruskal-Wallis test also showed a significant effect in the groups on their self-perception of health [χ^2 (3) = 20.124; $p < 0.001$]. Additionally, results of the post-hoc comparisons showed that the nonsports group had a worse self-perception of health than the strength sports group ($p = 0.011$), endurance sports group ($p = 0.003$), and mixed sports group ($p < 0.001$). The mixed sports group also showed better self-perception

Table II. Median and interquartile data about educational level, working daily hours, and restriction level adopted in the current pandemic.

	Strength sports (n = 142)	Endurance sports (n = 88)	Mixed sports (n = 48)	Nonsports (n = 26)	Kruskal-Wallis test
Educational level	6 (5-7)	7 (5-7)	7 (5-7)	7 (5-7)	χ^2 (3) = 2.535; $p = 0.469$
Working daily hours	8 (8-10)	9 (8-10)	8 (7-10)	8 (4-10)	χ^2 (3) = 3.347; $p = 0.341$
Restriction level	3 (2-3)	3 (2-4)	3 (2-3)	3 (3-3)	χ^2 (3) = 3.660; $p = 0.301$

Table III. Percentage values of each answer of each group.

	Strength sports (%)	Endurance sports (%)	Mixed sport (%)	Nonsports (%)
Depression level				
Minimal	43.0	59.1	68.8	38.5
Mild	34.5	27.3	25.0	26.9
Moderate	13.4	9.1	4.2	23.1
Moderate to severe	5.6	3.4	2.1	3.8
Severe	3.5	1.1	0	7.7
Anxiety level				
No anxiety	47.9	58.0	64.6	46.2
Mild	35.2	31.8	31.3	15.4
Moderate	16.9	10.2	4.2	30.8
Severe	0	0	0	7.7
Health self-perception				
Very bad	2.1	0	0	0
Bad	12.0	11.4	4.2	34.6
Good	21.1	25	14.6	30.8
Very good	47.2	37.5	41.7	23.1
Excellent	17.6	26.1	39.6	11.5

of health than the strength sports group (p = 0.002) and endurance sports group (p = 0.024). However, the strength and endurance sports groups showed similar self-perception health (p = 0.422) (Table IV).

Discussion

This study compared the health self-assessment and the depression and anxiety levels of four groups of subjects during the COVID-19 pandemic: aerobic sports, strength sports, mixed sports (strength and aerobic training), and nonsports groups. The main findings were as follows: (1) the mixed and aerobic sports groups presented lower depression levels than the strength sports and nonsports groups; (2) the mixed and aerobic sports groups presented lower anxiety levels than the nonsports group; (3) the mixed sports groups presented lower anxiety levels than the strength sports groups; (4) the mixed, strength, and aerobic sports groups presented better levels of health self-assessment than the nonsports group; and (5) the mixed sports group presented a better level of health self-assessment than the strength or aerobic sports groups.

These findings confirm the initial hypothesis that participants who engaged in mixed exercises had a higher health self-perception level than the other groups. However, the depression and anxiety levels were not different between the mixed and aerobic sports groups, which had lower levels than the nonsports group.

In the present study, the aerobic and mixed sports groups had lower depression levels than the nonsports group, but the depression levels of the strength sports group did not differ from that of the nonsports group. Previous studies[32,33,43,444] have extensively shown the positive effect of aerobic training on depression. A systematic review and meta-analysis by Papasavvas et al[32] concluded that depression level inversely correlated with cardiorespiratory fitness. Similarly, Loprinzi et al[43] found that low and medium cardiorespiratory fitness are associated with an increased risk of

Table IV. Median and interquartile values for depression, anxiety, and health self-perception of each group.

	Mixed sports group	Strength sports group	Aerobic sports group	Nonsports group
Depression level	0 (0-1)*#	1 (0-1)	0 (0-1)*#	1 (0-2)
Anxiety level	0 (0-1)*#	1 (0-1)	0 (0-1)*	1 (0-2)
Health self-perception	4 (4-5)*#&	4 (3-4)*	4 (3-5)*	3 (2-4)

*$p < 0.05$ (different from inactive sports group). #$p < 0.05$ (different from strength sports group). &$p < 0.05$ (different from endurance sports group).

mental health disorders. A 12-week exercise trial by Rahman et al[44] showed that increases in cardiorespiratory fitness reduced symptoms in people with depression, independent of exercise intensity, age, and body mass. Additionally, Silveira et al[33] also demonstrated that aerobic training can improve the response to conventional depression treatment.

Some hypotheses suggest that aerobic exercises affect mental health through physiological mechanisms, such as the enhancement of the synthesis and liberation of neurotrophic factors, changes in the inflammatory and oxidant profile, angiogenesis, neurogenesis, and plasticity[45].

Several regions in the brain undergo consistent volumetric reductions in depression. The hippocampus is one of the most studied brain regions in depression disorders and shows volume reduction in patients with depression[46]. On the other hand, a higher cardiorespiratory fitness resulting from aerobic exercises relates to a larger hippocampal volume[46,47]. Similar results have been demonstrated in other cerebral regions. For example, the anterior cingulate cortex (ACC) and the prefrontal cortex (PFC) are two other regions negatively impacted (reduced volumes) by depression[46,48,49]. In the same manner that exercise affects the hippocampus, cardiorespiratory fitness also positively affects the ACC and PFC volume, suggesting that aerobic exercise may benefit depression disorders[46,48]. Additionally, aerobic exercise can improve cardiorespiratory fitness that may reduce oxidative stress damage. Both inflammation and oxidative stress are implicated in the pathophysiology of common mental health disorders[50].

On the other hand, there was no significant difference in the depression and anxiety levels between the strength sports group and the nonsports group. Despite the relative consensus in the literature about the benefits of aerobic exercise on the treatment and prevention of depression and anxiety, the effects of strength exercise is somewhat controversial. Previous studies[51-53] demonstrated that strength training, when added to the usual depression treatment, promoted a greater reduction of depressive symptoms[51] and could also prevent depression[52,53]. However, there is no known effect of strength training on depression symptoms. Kim et al[54] concluded in their clinical trial study that there are no significant differences in depression level for those who performed strength training and for controls.

Despite the lack of consensus in the literature, studies[55-59] have proposed some possible mechanisms showing the positive effects of strength training on mental health. One possible mechanism is muscle strength gain. Stronger muscles are associated with better functional capabilities and lower risks of losing independence to do daily activities[55], which are conditions linked to depression symptoms[56-59]. Another possible mechanism is the release of cytokines and myokines in response to muscle contraction, which has protects against depression[60]. Additionally, an increased social contact has also been associated with depression symptoms[61]. Finally, strength exercises can also positively affect self-esteem, which is a global evaluation of self-worth and self-image, involving several components, such as cognitive, affective, and behavioral components[62], and which is also lower in people with depression[63]. Compared with those of nonexercizing controls, Schranz et al[64] found that strength training had a positive effect on physical self-worth and global self-concept in subjects.

Although the present results failed to show significant differences between the strength sports and nonsports groups in terms of depression and anxiety levels, the strength sports group presented a significantly higher level of health self-assessment than the nonsports group, and the mixed sports group presented a higher level of health self-assessment than the strength sports group. Muscular strength is a well-known important health indicator associated to a lower risk of metabolic syndrome and cardiovascular risk[65-67]. Moreover, a low muscular strength is also associated with frailty and health-related quality of life[68]. Therefore, we expected that individuals who were engaged in strengthening exercises would have a better health self-perception than inactive individuals. Additionally, another very interesting result is that participants from the mixed sports group have better health self-assessment, possibly because these individuals benefit from improved strength, which is closely related to the quality of life, in addition to cardiorespiratory fitness level improvement, which is also strongly associated with lower risks of several noncommunicable diseases[69]. Regarding the limitations of this study, there is a lack of data on the time that individuals practice their sport modality, and the sporting history of each participant may have influenced the interpretation of the results.

Conclusions

Physical activity is considered part of a healthy lifestyle and plays an important role in the COVID-19 pandemic. Compared with sedentary behavior, aerobic exercise can lower the depression and anxiety levels. Moreover, strength training can improve an individual's health self-assessment. However, this study could not determine the optimum type, frequency, and duration of exercise that are associated with better mental health. Exercise preference, access to resources, and social support may determine the best option for each person.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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Authors' Contribution

TSC drafted the initial manuscript; TSC and EC performed data acquisition; CABL, RLV, and MSA performed the statistical analysis and interpreted the data; MSA, AS, JCF, and GT were responsible for manuscript revision and preparation of this manuscript; TR and BK critically reviewed the manuscript. All authors have read and approved the final version of the manuscript and agree with the order of presentation of the authors.

Availability of Data and Materials

Data are available upon reasonable request to BK (corresponding author). De-identified participant data might be available after the consent of all authors and the privacy policy office of the Federal University of São Paulo.

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