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Research paper

Exercise behavior patterns and associations with subjective well-being during the COVID-19 pandemic: A cross-sectional study in Brazil [☆]



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ABSTRACT

Introduction: The COVID-19 pandemic has affected the behavior and practice of planned and structured physical exercises. This study aimed to investigate the association between changes in physical exercise behavior and subjective well-being during the COVID-19 pandemic in Brazil.

Methods: This cross-sectional study was performed in Brazil and included a total of 595 individuals recruited through social media platforms, personal and professional contacts. Each participant responded to self-completed questionnaire via an online survey between March 29 and May 7, 2020. The characteristics of physical exercise (frequency, intensity, and duration) were collected before and during the pandemic. The subjective state of mood was measured through the Profile of Mood States (POMS) questionnaire during the pandemic. A generalized linear model was employed for the analysis.

Results: Exercising during the pandemic only promoted protective effects on the subjective mood. An exercise frequency of 3-5 days/week was associated with improved vigor and between 6-7 days/week with improved vigor and total mood when compared to not exercising at all ($p < .005$). A moderate intensity was associated with improved vigor, and a high intensity with improved vigor, total mood, and less fatigue in comparison to low-intensity exercise programs ($p < 0.05$). Maintaining the same duration of exercise sessions during the pandemic was associated with lower scores of depression/anxiety, fatigue and irritability, and improved vigor and total mood, while performing longer sessions with improved vigor when compared to short exercise sessions ($p < .005$).

Conclusion: Regular exercising during the pandemic promotes positive changes in the subjective well-being. Our results reinforce the need for adopting and maintaining a physical exercise routine during the COVID-19 pandemic as a protective effect on mental health.

1. Introduction

COVID-19 is characterized by a respiratory viral infection caused by the SARS-COV2 virus and has triggered a global public, economic, and financial health crisis. The first cases were recorded in December 2019 in Wuhan, China, and to date COVID-19 has infected more than 157 million people, with over 3.2 million deaths worldwide [1]. Brazil is the country with the third-highest number of confirmed infections, and the country also has the world's second-highest number of deaths [1]. To mitigate the spread of the virus, certain measures have been established, i.e., frequent hand hygiene and social distancing, which has been effective methods for preventing the COVID-19 pandemic [2]. However,

social distancing has had negative impacts on psychological health, such as an increase in the symptoms of stress, anxiety, and depression [3, 4].

Performing physical exercise is an important factor for a healthy lifestyle and plays a fundamental role in the treatment and prevention of various health-related conditions by reducing symptoms of anxiety, depression and improving well-being [5]. Physical exercise is defined as a subset of physical activity that is planned, structured and repetitive, whose purpose is to improve or maintain physical fitness, while physical activity is any bodily movement produced by skeletal muscles that results in energy expenditure [6]. During physical exercise, neurotransmitters and trophic factors are released, i.e., endorphins, vascular endothelial growth factor (VEGF), serotonin, brain-derived neurotrophic

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factor (BDNF), which help to improve mental health, especially in mood responses [7, 8]. However, it is observed that social distancing due to the COVID-19 pandemic has caused a decline in physical activity levels and an increase in time spent in sedentary behavior among individuals who were previously active (i.e., > 150 min of moderate physical exercise or 75 min in vigorous-intensity), consequently worsening their mental health [9]. It is important to emphasize that even before the COVID-19 pandemic the world population faced the pandemic of physical inactivity and sedentary behavior [10]. Furthermore, most of the physical exercise environments were closed, hence it is recommended that people remain active at home following guidelines for physical exercise, i.e., frequency, intensity, and duration, to maintain or improve both physical and psychological health [11, 12].

Nevertheless, there is still little information regarding the association between physical exercise and mental health before and during social distancing in the context of COVID-19 in Brazil. This is an atypical condition, which allows an investigation on the effects of social distancing on well-being - which has brought about an imposed restriction on the practice of physical exercise. Thus, the present study aimed to investigate the association between the parameters of physical exercise before and during the COVID-19 pandemic on the subjective state of well-being. We hypothesize that exercising before and during social distancing is associated with more positive responses on the subjective state of well-being during the COVID-19 pandemic.

2. Material and methods

2.1. Design

This is a cross-sectional study and encompasses a larger project carried out by the International Research Group on COVID and exercise (IRG) [13]. Data collection occurred in 18 countries through an online survey on the Unipark™ platform, from March 29, 2020, to May 7, 2020. For this study, only information from Brazil was used. During this period, Brazil had recorded 6,935 cases and 600 deaths from COVID-19 [1]. The questionnaires were translated into Portuguese. The study followed the General Data Protection Regulation (EU) and APA's Ethical Research Guidelines [13, 14], for the immense variability of rules and legislations worldwide. We ensure in our study the APA recommendations for Dispensing with Informed Consent for Research: "(b) only anonymous questionnaires, naturalistic observations, or archival research for which disclosure of responses would not place participants at risk of criminal or civil liability or damage their financial standing, employability, or reputation, and confidentiality is protected" (<https://www.apa.org/ethics/code>). Participants interested in participating in the study voluntarily marked the option of accepting the Informed Consent Form. Ethical approval was waived for this study since all data collected were provided anonymously by participants. The study was reported according to the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) recommendations [15].

2.2. Participants

Participants were recruited via social media platforms (i.e., Twitter, Instagram, Facebook) and instructed to disseminate the research for their personal and professional contacts. A survey link was made available for the dissemination of the questionnaire. In Brazil, a total of 650 individuals responded to the questionnaire. Participants were excluded from the analysis if they: i) reported similar symptoms or a diagnosis of COVID-19 ($n = 45$); ii) did not answer the question regarding COVID-19 ($n = 10$). No statistical method was used to estimate the sample size a priori, however, the final sample ($n = 595$) achieved a statistical power ($1-\beta$) of 80%, which corresponds to the recommendations of a linear model [16].

2.3. Exposure measure

To assess exercise behavior, questions about the frequency, intensity, and duration of exercise sessions performed before and during the social distancing caused by the COVID-19 pandemic were included [13, 14]. Physical exercise was defined for the participants as any intended activity that involved body movement (i.e., physical training, exercises at home, soccer, swimming, walking, etc.). If the participant informed that they exercised as part of their occupation (i.e., personal trainer), this data was discarded.

Frequency: The frequency of exercise before and during social distancing was obtained through the following questions: "How often did you exercise in the weeks before COVID-19?" and "How often have you exercised lately during COVID-19?", respectively. Participants had the following response options: "Never", "Once in a while", "Once a week", "Two times a week", "Three times a week", "Four times a week", "Five times a week", "Six times a week" and "Every day". For statistical analysis, the answers "Never", "Once in a while", "Once a week" and "Two times a week" were combined as "1-2 days"; the answers "Three times a week", "Four times a week" and "Five times a week" were combined as "3-5 days"; and the responses "Six times a week" and "Every day" were combined as "6-7 days".

Intensity: The intensity of exercise sessions before and during social distancing was obtained through the following questions: "What would you say the intensity of this exercise was each time you did it before COVID-19?" and "What would you say the intensity of this exercise was each time you did it during COVID-19?". The response options were: "Low intensity", "Moderate intensity", "High intensity" and "Very high intensity". For data analysis, "High intensity" and "Very high intensity" were combined as "High intensity".

Duration: The duration of exercise sessions was obtained from the following question: "Were your exercise sessions during COVID-19 on average shorter or longer than before COVID-19?". The response options were "Shorter", "Longer" and "They were of about the same duration".

2.4. Outcome measure

The participants' subjective mood was assessed using the short version of the original Profile of Mood States (POMS) questionnaire [17]. This is a German version that was combined with the original English version, and translated from English to Portuguese by IRG members in Brazil [13]. This questionnaire contains 16 items related to the dimensions "depression/anxiety", "vigor", "fatigue" and "irritability". Furthermore, the total score of the dimensions representing mood states was included in the analysis. Lower values in the total score indicate a more positive mood. Participants answered how they were feeling "in the last few days during COVID-19", with the answer options on a Likert scale, being 1 (Not at all), 2 (A little), 3 (Moderately), 4 (Quite a bit) and 5 (Extremely). In the present study, the reliability of the POMS dimensions and total mood score were assessed, i.e., depression/anxiety (α Cronbach = 0.8), vigor (α Cronbach = 0.7), fatigue (α Cronbach = 0.9), irritability (α Cronbach = 0.9), and total mood (α Cronbach = 0.9).

2.5. Covariates

Socio-demographic data were collected, including age, gender, current region of residence, number of members living in the same household, family members under the age of 18, educational level, employment status, and family income.

2.6. Statistical analysis

Descriptive data are presented through mean and standard deviation, and also through absolute and relative frequency. The reliability of the POMS questionnaire was measured by Cronbach's alpha, with coefficient values ≥ 0.7 considered as the minimum acceptable threshold

Table 1
Socio-demographic characteristics of participants (n = 595).

Variables	N	Mean ± SD or n (%)
Gender, %	591	
Female		372 (62.9)
Male		219 (37.1)
Age, y	594	34.4 ± 11.6
Region, %	595	
North		2 (0.3)
Northeast		413 (69.4)
Midwest		3 (0.5)
Southeast		102 (17.1)
South		74 (12.4)
Federal District		1 (0.2)
Residence, %	595	
Urban		547 (91.9)
Suburban		34 (5.7)
Rural		14 (2.4)
Household composition, %	594	
1		70 (11.8)
2-3		317 (53.4)
4 or more		207 (34.8)
Household members under 18, %	524	
None		301 (57.4)
1		150 (28.6)
2 or more		73 (13.9)
Educational level, %	593	
Completed High School		166 (28)
Completed University		240 (40.5)
Graduate Studies		187 (31.5)
Employment status, %	593	
Unemployed		44 (7.4)
Retired		25 (4.2)
Student		108 (18.2)
Employed		416 (70.2)
Income, %	582	
No income		18 (3.1)
Very low to low income		96 (16.5)
Median income		362 (62.2)
High to very high income		106 (18.2)

N, total participants included in the study; n, number of participants who answered the information related to each socio-demographic variable. SD, standard deviation.

of reliability [18]. To compare physical exercise behavior before and during social distancing due to the COVID-19 pandemic, the chi-square test was employed. A generalized linear model was used to compare the total mood scores and dimensions of the POMS (depression/anxiety, vigor, fatigue, and irritability) during COVID-19, considering changes in physical exercise behavior (increased, no change, and decreased). The results were expressed as estimated marginal means (EMM) with a 95% confidence interval (95% CI), and as coefficient estimates (β) with a 95% CI. A generalized linear model was run to assess the influence of physical exercise behavior before and during the COVID-19 pandemic on total mood scores and POMS dimensions. For this analysis, the odds ratio (OR) was calculated with a 95% CI. The models were adjusted with covariates that showed significance for each outcome ($p < .05$). Data analysis was performed on SPSS 25.0, and a significance value of $p < .05$ was adopted.

3. Results

The final sample consisted of 595 participants. The missing data for each outcome was excluded from the analysis. Table 1 describes the participants' socio-demographic information. Most participants were female (62.9%), middle-aged adults, living in the northeast region (69.4%), and residing in urban areas (91.9%). Moreover, a greater proportion of participants had a household composed of 2 to 3 people (53.4%) and no family members under the age of 18 (57.4%). Most participants had an academic degree (40.5%), were employed (70.2%), and had a median family income (62.2%). Participants were asked whether

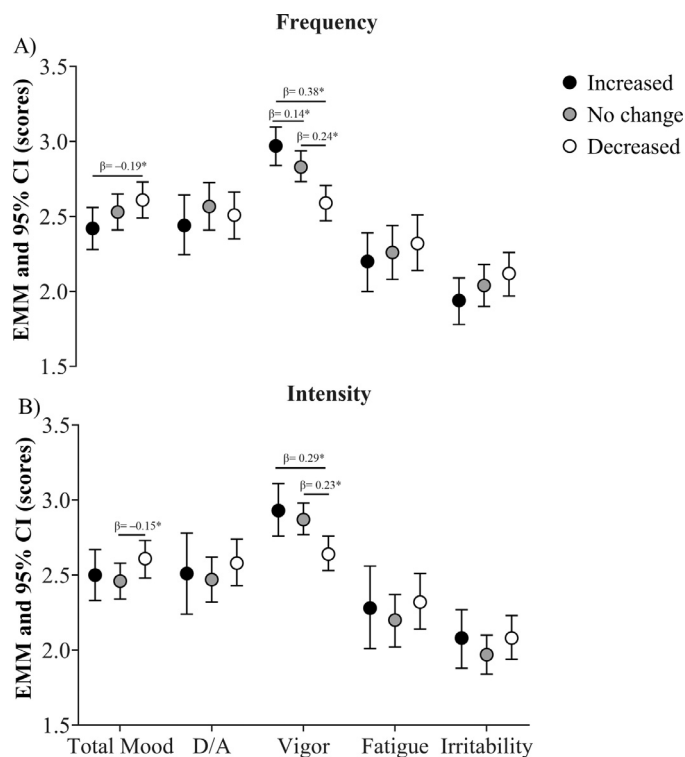


Fig. 1. Comparison of the total mood score and POMS dimensions during COVID-19, according to changes in frequency (Panel A) and exercise intensity (Panel B). β , coefficient estimates; D/A, depression/anxiety.

spaces for physical exercise were open or closed during the pandemic. It was reported that 98.6% of gyms, 56.8% of outdoor spaces, and 70.2% of parks were closed.

With regard to changes in exercise behavior before and during the pandemic, there was an increase in the number of participants who did not exercise during the period of social distancing. Furthermore, there was an increase in moderate-intensity workouts and a reduction in high-intensity training during social distancing due to the COVID-19 pandemic in comparison to the status before the pandemic. Ultimately, most participants reported that the duration of their physical exercise sessions was shorter during social distancing (Supplementary Table 1). Furthermore, 39.2% of participants reported having reduced their frequency of exercise, 39.5% related to making no changes and 21.3% reported an increase in the training frequency during the pandemic. Additionally, 38.4% of participants stated that the intensity of the exercise decreased, 51.8% reported no changes in intensity and 9.8% described an increase in intensity during the pandemic. Of the participants who exercised during the pandemic, 51.8% reported that the session duration was shorter, 34.5% stated that it was the same duration and 13.7% affirmed that the session was longer than before the pandemic. Figure 1 and Supplementary Table 2 show the total mood scores and POMS dimensions during COVID-19, considering the changes in exercise behavior. Participants who increased exercise frequency experienced fewer mood disorders (better total mood) during COVID-19, when compared to those who decreased the frequency ($\beta = -0.19$, $p = .004$), as well as greater vigor when compared to the participants who did not change their frequency ($\beta = 0.14$, $p = .049$) and to those who decreased exercise frequency ($\beta = 0.38$, $p < .001$). Participants who did not change the exercise frequency reported a greater vigor during COVID-19 compared to those who decreased it ($\beta = 0.24$, $p < .001$). With respect to exercise intensity, participants who did not change the intensity presented fewer mood disorders (better total mood) during COVID-19 when compared to those who decreased their exercise sessions intensity ($\beta = -0.15$,

Table 2

Associations between exercise behavior before and during the COVID-19 pandemic with total mood and POMS dimensions.

	Total Mood ^a		Depression/Anxiety ^b		Vigor ^c		Fatigue ^a		Irritability ^d	
	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>
Exercise frequency before	<i>n</i> = 575		<i>n</i> = 566		<i>n</i> = 583		<i>n</i> = 564		<i>n</i> = 578	
Never	(Ref)		(Ref)		(Ref)		(Ref)		(Ref)	
1-2 days	0.99 (0.76; 1.29)	.953	1.22 (0.87; 1.72)	.254	1.03 (0.79; 1.33)	.850	1.02 (0.69; 1.52)	.904	0.87 (0.63; 1.19)	.372
3-5 days	0.98 (0.77; 1.26)	.897	1.22 (0.89; 1.69)	.222	1.01 (0.79; 1.28)	.959	0.86 (0.60; 1.25)	.437	0.94 (0.70; 1.26)	.672
6-7 days	0.91 (0.70; 1.19)	.494	1.16 (0.82; 1.64)	.389	1.21 (0.93; 1.59)	.155	0.82 (0.56; 1.22)	.339	0.93 (0.68; 1.28)	.668
Exercise frequency during	<i>n</i> = 575		<i>n</i> = 566		<i>n</i> = 583		<i>n</i> = 564		<i>n</i> = 578	
Never	(Ref)		(Ref)		(Ref)		(Ref)		(Ref)	
1-2 days	0.98 (0.81; 1.20)	.858	0.93 (0.72; 1.20)	.568	1.13 (0.92; 1.39)	.238	1.13 (0.84; 1.52)	.416	0.94 (0.72; 1.21)	.616
3-5 days	0.87 (0.72; 1.04)	.128	0.99 (0.78; 1.26)	.938	1.44 (1.18; 1.75)	<.001	0.90 (0.69; 1.18)	.451	0.91 (0.72; 1.16)	.444
6-7 days	0.74 (0.60; 0.74)	.005	0.96 (0.72; 1.29)	.795	1.84 (1.48; 2.30)	<.001	0.76 (0.57; 1.03)	.072	0.78 (0.60; 1.02)	.073
Exercise intensity before	<i>n</i> = 536		<i>n</i> = 527		<i>n</i> = 542		<i>n</i> = 525		<i>n</i> = 537	
Low	(Ref)		(Ref)		(Ref)		(Ref)		(Ref)	
Moderate	1.00 (0.83; 1.20)	.958	1.07 (0.81; 1.43)	.623	1.08 (0.87; 1.34)	.507	0.90 (0.65; 1.24)	.525	1.04 (0.83; 1.30)	.726
High	0.96 (0.80; 1.16)	.668	1.05 (0.79; 1.40)	.726	1.13 (0.91; 1.40)	.260	0.82 (0.59; 1.12)	.213	1.08 (0.86; 1.36)	.482
Exercise intensity during	<i>n</i> = 510		<i>n</i> = 501		<i>n</i> = 518		<i>n</i> = 500		<i>n</i> = 513	
Low	(Ref)		(Ref)		(Ref)		(Ref)		(Ref)	
Moderate	0.89 (0.76; 1.04)	.144	1.00 (0.80; 1.25)	.996	1.31 (1.08; 1.59)	.005	0.81 (0.62; 1.06)	.128	0.95 (0.77; 1.17)	.632
High	0.81 (0.68; 0.97)	.022	0.96 (0.75; 1.24)	.767	1.53 (1.24; 1.88)	<.001	0.70 (0.53; 0.94)	.016	0.99 (0.78; 1.25)	.920
Exercise duration	<i>n</i> = 509		<i>n</i> = 500		<i>n</i> = 517		<i>n</i> = 499		<i>n</i> = 512	
Shorter	(Ref)		(Ref)		(Ref)		(Ref)		(Ref)	
Same duration	0.77 (0.69; 0.86)	<.001	0.75 (0.65; 0.88)	<.001	1.23 (1.08; 1.39)	.001	0.74 (0.62; 0.87)	<.001	0.77 (0.67; 0.88)	<.001
Longer	0.96 (0.82; 1.12)	.580	1.11 (0.89; 1.38)	.372	1.28 (1.09; 1.49)	.002	0.93 (0.73; 1.19)	.574	1.08 (0.86; 1.36)	.496

Bold values denote statistical significance at the $p < 0.05$.

OR, Odds ratio; 95 % CI, 95% confidence interval.

^a Adjusted for gender, age, employment status, and income.^b Adjusted for gender, age, educational level, employment status, and income.^c Adjusted for gender, age, and employment status.^d Adjusted for age, household composition, and employment status.

$p = .007$); while participants who increased it ($\beta = 0.29, p = .002$) and did not change the intensity ($\beta = 0.23, p < .001$) reported a greater vigor in relation to those who decreased their exercise intensity.

Table 2 shows the results of the association between exercise behavior and mood. Performing physical exercise before the COVID-19 pandemic did not promote significant changes on the responses of total mood, depression/anxiety, vigor, fatigue, and irritability ($p > .05$). During the COVID-19 pandemic, participants who had an exercise frequency of 3-5 days/week showed improved vigor (OR = 1.44, $p < .001$) and between 6-7 days/week both improved vigor (OR = 1.84, $p < .001$) and mood (OR = 0.74, $p = .005$) in comparison to those who did not exercise at all. Participants who exercised at moderate intensity during the COVID-19 pandemic had improved vigor (OR = 1.31, $p = .005$), while participants who performed high-intensity sessions presented improved vigor (OR = 1.53, $p < .001$), mood (OR = 0.81, $p = .022$) and less fatigue (OR = 0.70, $p = .016$) compared to those who performed low-intensity training sessions. Besides, participants who maintained the same duration of the exercise session during the COVID-19 pandemic had lower scores of depression/anxiety (OR = 0.75, $p < .001$), fatigue (OR = 0.74, $p < .001$) and irritability (OR = 0.77, $p < .001$), and improved vigor (OR = 1.23, $p = .001$) and mood (OR = 0.77, $p < .001$), while those with the longest session duration only showed improved vigor (OR = 1.28, $p = .002$), when compared to participants who performed the shortest sessions.

4. Discussion

The present study aimed to investigate the impact of physical exercise before and during the COVID-19 pandemic on the subjective state of well-being. The main findings of this study are: i) participants who maintained and increased the frequency and intensity of exercise sessions had a better total mood and vigor during the pandemic when compared to those who decreased these factors; ii) more specifically, exercising between 3-5 days/week and 6-7 days/week promoted a better total mood and vigor when compared to not exercising at all; meanwhile, moder-

ate and high-intensity exercise sessions promoted a better total mood, vigor, and less fatigue when compared to low-intensity sessions, and maintaining the same duration and having a longer session provided more positive responses in the total mood and in the POMS dimensions (i.e., depression/anxiety, fatigue, irritability, and vigor) compared to performing shorter sessions during the pandemic.

The COVID-19 pandemic has affected exercise behavior and promoted negative impacts on mental health. In our study, it was observed that 39.2% of participants decreased the frequency of exercise sessions, while 39.5% reported no changes, and 21.3% increased the frequency of their workouts during the pandemic. The increase in the frequency of exercise provided more positive responses on total mood and vigor during the pandemic compared to a decrease in frequency. This pattern of exercise frequency differs from other studies, as we found higher results for participants who reported having decreased the frequency, and lower values for those who reported no changes on frequency [13, 14] and an increased frequency of exercise sessions [13]. These differences can be partially explained by government restrictions. In our study, most participants reported that gyms (i.e., 98.5%), outdoor spaces (i.e., 56%), and parks (i.e., 69.3%) were closed, which may have been determinant in these changes in exercise behavior. During the pandemic period, the recommendations of the World Health Organization related to physical exercise practices were to increase the minimum frequency from 3 days/week to 5 days/week [19]. These recommendations were adjusted to compensate for the drastic changes that occurred in the daily routine of the population (i.e., reduced levels of physical activity, and increased periods spent watching TV and using a computer/tablet) [20], and consequently, to avoid negative implications for physical and mental health arising from COVID-19.

Furthermore, our results indicate that exercising at least 3 days/week was sufficient to improve the total mood and the specific dimensions, i.e., vigor, confirming the protective effects of physical exercise on mental health. Regular exercising stimulates the physiological functions (i.e., increased endorphins and BDNF, reduced cortisol levels) [7, 8], psychological aspects (i.e., improved self-efficacy and general well-being) [21],

and psychophysiological mechanisms which may be related to improvements in the subjective state of well-being during the pandemic. Our results indicate that it is possible to achieve improvements in parameters related to mental health when exercising 3 days/week, something that can serve as a stimulus to maintain and/or increase the frequency of exercise sessions, and consequently relish the additional benefits caused by regular physical exercise, particularly for people who face greater difficulties in engaging and adhering to physical exercise routines.

Regarding the intensity of exercise sessions, it was found that 38.4% of participants decreased it, 51.8% reported no changes, and only 9.8% increased the intensity during the pandemic. These findings are consistent with previous surveys, in which the majority of participants reported no changes, while a smaller amount mentioned a decrease in intensity, and only a very small proportion of participants reported an increase in exercise intensity [13, 14]. In our study, the maintenance of exercise intensity provided fewer total mood disturbances, indicating a better mood, while the increase of intensity together with the maintenance led to a greater vigor in comparison to the decrease of intensity. Additional analysis indicated that moderate and high-intensity exercises provided positive changes in vigor, and only high-intensity sessions induced improvements in total mood, vigor, and fatigue compared to low intensity ones. These results corroborate a recent systematic review that found improvements in total mood and the specific dimensions (i.e., anxiety, depression, calm, and vigor) after moderate and high-intensity exercises [22].

Mood swings can be explained through psychological and neurophysiological mechanisms. Previous research has shown that moderate-intensity exercise increases circulating endocannabinoids levels [23], which can contribute to a positive mood, lower depression and tension, and greater post-exercise vigor [24]. In high-intensity exercise sessions, an increase in the cortical activation of the dorsolateral prefrontal cortex has been observed [25], which is a brain area associated with fewer total mood disorders, that is, a better mood [26]. Based on the aforementioned, despite the benefits associated with moderate and high-intensity training, it is essential to adjust the training program according to the individual's fitness level and personal preferences, and also to adapt it to individual characteristics.

The association between physical exercise and well-being is also influenced by the duration of the session [22]. Our findings highlight that maintaining the duration of exercise sessions during the pandemic was an important factor for improving subjective states of depression/anxiety, vigor, fatigue, and irritability, while longer sessions help to increase vigor. The literature has shown that sessions between 10-30 min long are sufficient to improve mood and its specific dimensions [22]. Before the pandemic, one of the main barriers cited for physical exercise was the lack of time, mainly because people had to go to physical activity spaces (i.e., gyms, parks) [27]. Notwithstanding, the majority (96%) of participants who exercised during the pandemic reported having sessions lasting longer than 10 min (data not shown). Thus, it is recommended to stimulate the population to keep exercising even in short sessions (i.e., 10 min), due to the benefits associated with the improvement of well-being.

Finally, in the present study no protective effects of physical exercise performed before the pandemic were found on total mood and in its specific dimensions (i.e., depression/anxiety, vigor, fatigue, and irritability) during the pandemic. It is recognized that the social distancing caused by the COVID-19 pandemic has caused significant damage to people's emotional state [3]. For this reason, we believe that only physical exercise performed during the pandemic has provided immediate positive effects on mental health. In fact, participants who were active before the pandemic and who were deprived of their usual physical exercise routines may experience a worsening of mood state, due to the withdrawal effect or the adversity of adapting their routine. Hence, our results reinforce the relevance of developing strategies that enable the regular practice of physical exercises during the pandemic. For example, home-based physical exercise such as aerobic exercises (i.e., walking up

and down stairs, walking indoors carrying light or moderate items and dancing) and bodyweight exercises (i.e., squat with or without support, push-up with support on the wall or floor), are possibilities that can be implemented to promote physical and mental health benefits [11, 28, 29]. Although it is challenging, it is increasingly important to strengthen the message "move more, sit less, some movement is good and more is better", to achieve the recommendations for physical exercise during this pandemic period [30].

As study limitations, we believe that questions related to physical exercise behavior before the pandemic may be subject to memory bias, mainly because it is a self-reported measure. Furthermore, this was a cross-sectional study, which is not designed to establish causal relationships. The nature of online data collection may also have limited the sample to certain groups (such as younger people familiar with social communication technologies) [13]. Also, as the study aimed to understand the parameters of physical exercise, the research may have drawn the attention of people already engaged in physical exercise. Despite this, it should be noted that 26% and 35% of our sample had a frequency of fewer than 3 times a week of physical exercise before and during the pandemic, respectively. As for the strengths of the present study, we may mention the fact that the research started and was conducted during the beginning of the first wave of the pandemic (COVID-19) in Brazil, allowing the opportunity to investigate changes in exercise behavior [13]. Furthermore, our results provide information that can assist professionals in the prescription of physical exercise activities to favor positive changes in mental health during the pandemic considering the parameters of frequency, intensity, and duration.

5. Conclusion

Regular physical exercise during the COVID-19 pandemic is associated with positive changes in the subjective well-being. Increasing or not changing the exercise frequency led to better outcomes compared to decreasing it. Three or more sessions per week were better for the total mood and vigor responses in comparison to not exercising at all. Increasing or not changing the workout intensity was better than reducing it. Moderate or high-intensity sessions were better for the total mood, vigor, and fatigue dimensions. The maintenance of duration or having longer sessions led to the best outcomes in the total mood, depression/anxiety, fatigue, and irritability responses compared to reduced sessions. Thus, maintaining a regular physical exercise routine is essential for improving mental health in periods of social distancing related to the pandemic, and can contribute to mitigating possible harmful impacts associated with COVID-19.

Author Contribution

Gledson Tavares Amorim Oliveira: Conceptualization, Methodology, Data curation, Formal analysis, Writing – original draft, Writing – review & editing. **Andressa de Oliveira Araújo:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Lídia Reniê Fernandes da Silva:** Conceptualization, Methodology, Data curation, Writing – original draft, Writing – review & editing. **Maristela Linhares:** Conceptualization, Methodology, Data curation, Writing – original draft, Writing – review & editing. **Lucas Camilo Pereira:** Writing – original draft, Writing – review & editing. **Mayra Nascimento Matias de Lima:** Writing – original draft, Writing – review & editing. **Hassan Mohamed Elsagedy:** Conceptualization, Methodology, Supervision, Writing – original draft, Writing – review & editing.

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Declaration of Competing Interests

None.

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Data Availability

The datasets in the present study can be obtained from the author corresponding on request.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.eujim.2021.101374](https://doi.org/10.1016/j.eujim.2021.101374).

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