**Associations of moderate to vigorous physical activity and sedentary behavior with depressive and anxiety symptoms in self-isolating people during the COVID-19 pandemic: A cross-sectional survey in Brazil**

Felipe B. Schucha,\*, Rugero A. Bulzinga, Jacob Meyerb, Davy Vancampfortc, Joseph Firthd,e, Brendon Stubbsf,g, Igor Grabovach, Peter Willeiti,j, Vagner Deuel O. Tavaresk, Vitor C. Calegarol, Jeroen Deenikm,n, Guillermo F. López-Sánchezo, Nicola Veronesep, Cristina M. Caperchioneq, Kabir P. Sadaranganir,s, Mohammad Abufarajt.u, Mark A. Tullyv#, Lee Smithw#

**#Joint final author**

1. Department of Sports Methods and Techniques, Federal University of Santa Maria, Santa Maria, RS, Brazil.
2. Iowa State University, Ames, IA, United States of America.
3. KU Leuven Department of Rehabilitation Sciences, Leuven, Belgium.
4. Division of Psychology and Mental Health, University of Manchester, Manchester, UK.
5. NICM Health Research Institute, Western Sydney University, Westmead, Australia.
6. Department of Psychological Medicine, Institute of Psychiatry, Psychology and Neuroscience, King's College London, London, UK.
7. Physiotherapy Department, South London and Maudsley NHS Foundation Trust, London, UK.
8. Department of Social and Preventive Medicine, Centre for Public Health, Medical University of Vienna, Vienna, Austria.
9. Department of Neurology, Medical University of Innsbruck, Innsbruck, Austria.
10. Department of Public Health and Primary Care, University of Cambridge, Cambridge, UK.
11. Laboratory of Hormone Measurement, Department of Physiology and Behavior, Federal University of Rio Grande do Norte, Natal, Brazil.
12. Department of Neuropsychiatry, Federal University of Santa Maria, Santa Maria, RS, Brazil.
13. Scientific Research Department, GGz Centraal, Amersfoort, the Netherlands
14. School for Mental Health and Neuroscience, Maastricht University, Maastricht, the Netherlands.
15. Faculty of Sport Sciences, University of Murcia, Murcia, Spain.
16. Geriatric Unit, Department of Internal Medicine and Geriatrics, University of Palermo, 90100 Palermo, Italy.
17. School of Sport, Exercise and Rehabilitation, Human Performance Research Centre, University of Technology Sydney, Sydney, NSW, Australia.
18. School of Physiotherapy, Faculty of Health Sciences, Universidad San Sebastian, Santiago 7510157, Chile.
19. Escuela de Kinesiología, Facultad de Salud y Odontología, Universidad Diego Portales, Santiago 8370057, Chile.
20. Department of Urology, Medical University of Vienna, Vienna, Austria.
21. Division of Urology, Department of Special Surgery, Jordan University Hospital, The University of Jordan, Amman, Jordan.
22. Institute of Mental Health Sciences, School of Health Sciences, Ulster University, Newtownabbey, UK.
23. The Cambridge Centre for Sport and Exercise Sciences, Anglia Ruskin University, Cambridge, CB1 1PT, UK.

**Running title: PA, SB, depression, and anxiety during COVID-19.**

\*=Corresponding author:

Felipe Barreto Schuch (felipe.schuch@ufsm.br)

Federal University of Santa Maria, Santa Maria, RS, Brazil.

Av. Roraima, 1000, Prédio 51 (CEFD), sala 1025. CEP:07105-900

Phone: +55 55 3220 7788

**Abstract**

This is a cross-sectional study evaluating the associations of self-reported moderate to vigorous physical activity, sedentary behavior with depressive, anxiety, and co-occurring depressive and anxiety symptoms (D&A) in self-isolating Brazilians during the COVID-19 pandemic. Depressive and anxiety symptoms were collected using the Beck Depression and Anxiety Inventories (BDI and BAI). Among the 937 participants (females=72.3%), those performing ≥30 min/day of moderate to vigorous or ≥15 min/day of vigorous physical activity had lower odds of prevalent depressive, anxiety, and co-occurring D&A symptoms. Those spending ≥10 h/day sedentary were more likely to have depressive symptoms.

**Key Words:** COVID-19, Depression, Physical Activity.

1. **Introduction**

The coronavirus disease 2019 (COVID-19) pandemic, is a global public health emergency. To slow the spread of the virus, federal governments recommended the adoption of social distancing measures, including self-isolation (World Health Organization, 2020). While self-isolation reduces the infection rate (Bedford et al., 2020), those measures, together with the “pandemic fear” (Ornell et al., 2020; Silva et al., 2020) are linked to a negative burden on mental health, possibly increasing depressive and anxiety symptoms (Brooks et al., 2020; Wang et al., 2020). Therefore, strategies to mitigate this mental health burden are necessary (Holmes et al., 2020).

Physical activity is associated with a lower prevalence of and incidence of depression and anxiety (Schuch et al., 2019; Schuch et al., 2018; Stubbs et al., 2016; Teychenne et al., 2020). On the other hand, sedentary behavior (SB) is associated with depressive (Hallgren et al., 2020; Zhai et al., 2015) and anxiety symptoms (Teychenne et al., 2015). However, it is seen that physical activity levels decreased (Ammar et al., 2020; Lesser and Nienhuis, 2020; Meyer et al., 2020; Rogers et al., 2020; Smith et al., 2020; Stanton et al., 2020) and time spent in SB increased (Meyer et al., 2020; Qin et al., 2020; Rogers et al., 2020; Stanton et al., 2020) during in self-isolating people.

Given the influence of the COVID-19 crisis on lifestyle behaviors, depressive, and anxiety symptoms, and the associations between depressive and anxiety symptoms, it is essential to understand the relationship between MVPA and SB with depressive/anxiety symptoms in the context of COVID-19 in Brazil. The present study aimed to explore the associations between MVPA, VPA, MPA, and SB with depressive, anxiety, and comorbid depression and anxiety (D&A) symptoms in self-isolating Brazilians.

1. **Methods**

This is a cross-sectional study collected via an online survey. The study was approved by the Federal University of Santa Maria Research Ethics Committee and by the National Commission of Ethics in Research [CONEP] (30244620.1.0000.5346).

2.1 Recruitment and inclusion criteria

Participants were recruited through social media (Facebook, Instagram, and Twitter) and by distributing an invitation to participate through existing researcher networks. Brazilians adults (≥18 years), currently residing in Brazil and in self-isolation due to the COVID-19 pandemic, were eligible to participate. By self-isolation, we mean those that decided to stay-at-home and only left for essential activities such as food shopping, visit the pharmacist or other health professionals.

*2.2 Variables*

2.2.1. Depressive symptoms

Depressive symptoms were assessed using the Beck Depression Inventory (BDI). The BDI is composed of 21 items with a score range from 0 to 63. For the study, depression was dichotomized into no depressive symptoms (0-9) or prevalent depressive symptoms (10-63) (Beck et al., 1961).

2.2.2 Anxiety symptoms

Anxiety symptoms were assessed using the Beck Anxiety Inventory (BAI). The BAI is composed of 21 items with a score range from 0 to 63. For the study purpose, anxiety was dichotomized into no anxiety symptoms (0-7) or prevalent anxiety symptoms (8-63) (Beck et al., 1988).

2.2.3 Co-occurring D&A symptoms

Those with prevalent depression and anxiety symptoms (BDI>9+BAI>7) were classified as having co-occurring D&A symptoms. Co-occurring D&A symptoms was treated as a dichotomous variable.

2.2.4 Moderate to Vigorous Physical Activity (MVPA)

Time spent in MVPA was assessed by two questions, as used in a previous study (Smith et al., 2020) : 1) “How much time on an average day have you spent in vigorous physical activity since self-isolating?”; and 2) “How much time on an average day have you spent in moderate physical activity since self-isolating?”. For the logistic models, MVPA and MPA were dichotomized into 1=<30 minutes per day, or 2=≥30 minutes/day, and VPA was dichotomized into 1=<15 minutes/day, or 2=≥15 minutes of VPA/day. These cutoffs are in line with the public health recommendations of 150 minutes of MVPA, or 75 minutes of VPA per week (World Health Organization, 2010).

2.2.5 Sedentary behavior (SB)

Time spent sitting, henceforth defined as SB, was assessed using the question: “Since self-isolating, how much time have you spent sitting daily?”. SB was treated as a dichotomous variable for logistic models (1=<10 hours spent sitting/day; 2=≥10 hours spent sitting/day). The cutoff is based on a previous study (Gibson et al., 2017) and the median of our study sample (equal to 10 hours).

*2.2.6 Covariates*

Demographic data were collected, including sex, age, ethnicity, marital status, employment, and household income, and Brazilian state they lived in. Participants were asked whether they are in self-isolation and to report the number of days in self-isolation. Current smoking and alcohol consumption were evaluated. Self-reported previous diagnosis of chronic physical conditions and previous diagnosis of psychiatric conditions were also evaluated with a list with a series of conditions.

*2.3 Statistical analyses*

Descriptive data are shown using mean (standard deviation), or median and interquartile range (IQR) for continuous variables. Categoric variables are shown as the total number of cases (%). The associations between MVPA, VPA, MPA, or SB with the prevalence of symptoms of mental health outcomes (depressive, anxiety, or D&A) were tested with logistic (using dichotomic variables) and linear (using continuous variables) regressions. First, the models were tested without adjustments (crude). Second, the models were adjusted for age, sex, ethnicity, marital status, employment, family income (adjusted 1). Third, the models were adjusted for age, sex, ethnicity, marital status, family income, days in self-isolation, current smoking, current alcohol consumption, lifetime diagnosis of chronic diseases, lifetime diagnosis of psychiatric disorders, time spent sitting (for MVPA, VPA and MPA models) or time spent in MVPA (for SB models) (adjusted 2). Regressions models were entered by blocks following the order: block 1 (crude), block 2 (adjusted 1), and block 3 (adjusted 2). Results from the logistic and linear regression models are presented as odds ratios (ORs) and beta coefficients together with their 95% confidence intervals (CIs), respectively. We adopted a statistical significance level at p <0.05. The statistical analysis was performed with SPSS version 22.0 (IBM Corporation).

1. **Results**

A total of 937 adults were included in the study. The sample was predominantly composed of women (72.3%), and young adults aged 18-35 (52.6%). The full details of the overall sample, and stratified by the time spent in MVPA and SB, are detailed in supplementary table 1.

In the most adjusted models (adjusted 2), those reporting ≥30 minutes in MVPA/day had a decreased odds of prevalent depressive (OR=0.71, 95%CI=0.53-0.96), anxiety (OR=0.72, 95%CI=0.54-0.96), and co-occurring D&A (OR=0.71, 95%CI=0.52-0.96) symptoms, and those spending ≥15 minutes in VPA/day had with lower odds of presenting depressive (OR=0.60, 95%CI=0.43-0.82), anxiety (OR=0.70, 95%CI=0.51-0.96), and co-occurring D&A (OR=0.59, 95%CI=0.41-0.83) symptoms. Spending ≥30 minutes MPA/day was associated with a lower prevalence of co-occurring D&A symptoms (OR=0.72, 95%CI=0.53-0.98). Those spending ≥10 hours in SB/day were more likely to present depressive symptoms (OR=1.39, 95%CI=1.02-1.90). The results of the logistic regression models are presented in table 1.

Linear regression models adjusting for relevant covariates (adjusted 2), testing the dose-response association, found that every 10 minutes spent in VPA is associated with 0.18 (95%CI=0.04-0.33) points lower on the BDI, and 0.21 (95%CI=0.03-0.40) points lower on the BAI scales, respectively. Also, each hour spent in SB is associated with 0.22 points higher on the BDI (95%CI=0.10-0.33) and 0.16 points higher at the BAI (95%CI=0.02-0.31). The linear models can be seen in supplementary table 2.

1. **Discussion**

In the present study, participants reporting ≥30 minutes in MVPA/day were approximately 30% less likely to present depressive, anxiety, and D&A symptoms. Those reporting ≥15 minutes of VPA/day were approximately 40% less likely to present prevalent depressive and D&A symptoms, and 30% less likely to present prevalent anxiety symptoms. Those spending ≥10 hours/day in SB were 39% more likely to present prevalent depressive symptoms.

Our findings are consistent with previous studies during the pandemic, suggesting that higher MVPA levels are associated with reduced depressive, anxiety and co-occurring D&A symptoms (Jacob et al., 2020; Meyer et al., 2020; Qin et al., 2020; Stanton et al., 2020). Interestingly, no associations were seen between MPA and depressive or anxiety symptoms. A potential explanation is that, during the pandemic, time spent in MPA might be heavily influenced by time spent in household activities that fall within the moderate-intensity range (Ainsworth et al., 2011), while VPA is more likely to reflect the leisure-time physical activity. It is well known that leisure-time physical activity is more closely associated with positive mental health outcomes than household activities (Teychenne et al., 2020).

Interestingly, those spending over 10 hours in SB/day were more likely to present prevalent depressive, but not anxiety or co-occurring D&A symptoms (Hallgren et al., 2018; Zhai et al., 2015). It is possible that periods longer than 10 hours/day of SB are needed to significantly increase anxiety symptoms (Hallgren et al., 2020).

The present study has some limitations. First, the cross-sectional design does not allow to draw any directionality in the relationship. Second, the sample was mostly composed of females and young adults recruited by social media (Facebook, Instagram, Twitter), living in three states (about 83% are from Rio Grande do Sul, Rio de Janeiro, or Ceará). Third, we could not rule out a sampling bias as those who are experiencing more depressive and anxiety symptoms might be more interested in participating in the study (self-selection bias). Fourth, all data was was self-reported that might suffer from recall bias and social desirability.

1. **Conclusion**

People reporting over 30 minutes of MVPA/day or over 15 minutes of VPA/day are less likely to present depressive, anxiety, and D&A symptoms. However, those reporting higher levels of SB are more likely to present prevalent depressive symptoms.

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**Authors contributions**

Study conception and design: Felipe Schuch, Lee Smith, Mark Tully. Acquisition of data: Felipe Schuch, Rugero Bulzing. Analysis and interpretation of data: Felipe Schuch, Davy Vancampfort, Jeroen Deenik, Brendon Stubbs, Peter Willeit. Drafting of manuscript: Felipe Schuch. Critical revision: All authors.

**References**

Ainsworth, B.E., Haskell, W.L., Herrmann, S.D., Meckes, N., Bassett, D.R.J., Tudor-Locke, C., Greer, J.L., Vezina, J., Whitt-Glover, M.C., Leon, A.S., 2011. 2011 Compendium of Physical Activities: A Second Update of Codes and MET Values. Medicine & Science in Sports & Exercise 43 (8).

Ammar, A., Brach, M., Trabelsi, K., Chtourou, H., Boukhris, O., Masmoudi, L., Bouaziz, B., Bentlage, E., How, D., Ahmed, M., 2020. Effects of COVID-19 Home Confinement on Eating Behaviour and Physical Activity: Results of the ECLB-COVID19 International Online Survey. Nutrients 12 (6), 1583.

Beck, A.T., Epstein, N., Brown, G., Steer, R.A., 1988. An inventory for measuring clinical anxiety: psychometric properties. J Consult Clin Psychol 56 (6), 893-897.

Beck, A.T., Ward, C.H., Mendelson, M., Mock, J., Erbaugh, J., 1961. An inventory for measuring depression. Arch Gen Psychiatry 4, 561-571.

Bedford, J., Enria, D., Giesecke, J., Heymann, D.L., Ihekweazu, C., Kobinger, G., Lane, H.C., Memish, Z., Oh, M.-d., Schuchat, A., 2020. COVID-19: towards controlling of a pandemic. The Lancet 395 (10229), 1015-1018.

Brooks, S.K., Webster, R.K., Smith, L.E., Woodland, L., Wessely, S., Greenberg, N., Rubin, G.J., 2020. The psychological impact of quarantine and how to reduce it: rapid review of the evidence. The Lancet.

Gibson, A.-M., Muggeridge, D., Hughes, A., Kelly, L., Kirk, A., 2017. An examination of objectively-measured sedentary behavior and mental well-being in adults across week days and weekends. PLoS One 12, e0185143.

Hallgren, M., Owen, N., Stubbs, B., Zeebari, Z., Vancampfort, D., Schuch, F., Bellocco, R., Dunstan, D., Lagerros, Y.T., 2018. Passive and mentally-active sedentary behaviors and incident major depressive disorder: a 13-year cohort study. Journal of affective disorders 241, 579-585.

Hallgren, M., Owen, N., Vancampfort, D., Dunstan, D.W., Wallin, P., Andersson, G., Ekblom-Bak, E., 2020. Associations of sedentary behavior in leisure and occupational contexts with symptoms of depression and anxiety. Prev Med 133, 106021.

Holmes, E.A., O'Connor, R.C., Perry, V.H., Tracey, I., Wessely, S., Arseneault, L., Ballard, C., Christensen, H., Cohen Silver, R., Everall, I., Ford, T., John, A., Kabir, T., King, K., Madan, I., Michie, S., Przybylski, A.K., Shafran, R., Sweeney, A., Worthman, C.M., Yardley, L., Cowan, K., Cope, C., Hotopf, M., Bullmore, E., 2020. Multidisciplinary research priorities for the COVID-19 pandemic: a call for action for mental health science. The Lancet Psychiatry.

Jacob, L., Tully, M., Barnett, Y., López-Sánchez, G., Butler, L., Schuch, F., Lopez, R., McDermott, D., Firth, J., Grabovac, I., Yakkundi, A., Armstrong, N., Young, T., Smith, L., 2020. The Relationship between Physical Activity and Mental Health in a Sample of the UK Public: A Cross-Sectional Study During the Implementation of COVID-19 Social Distancing Measures. Mental Health and Physical Activity(In press).

Lesser, I.A., Nienhuis, C.P., 2020. The Impact of COVID-19 on Physical Activity Behavior and Well-Being of Canadians. International journal of environmental research and public health 17 (11), 3899.

Meyer, J., McDowell, C., Lansing, J., Brower, C., Smith, L., Tully, M., Herring, M., 2020. Changes in physical activity and sedentary behaviour due to the COVID-19 outbreak and associations with mental health in 3,052 US adults.

Organization, W.H., 2010. Global recommendations on physical activity for health. World Health Organization.

Organization, W.H., 2020. Coronavirus disease 2019 (‎COVID-19)‎: situation report, 114.

Ornell, F., Schuch, J.B., Sordi, A.O., Kessler, F.H.P., 2020. Pandemic fear and COVID-19: mental health burden and strategies. Brazilian Journal of Psychiatry.

Qin, F., Song, Y., Nassis, G., Zhao, L., Cui, S., Lai, L., Wu, Z., Xu, M., Qu, C., Dong, Y., Wang, Z., Geng, X., Zhao, C., Feng, Y., Han, Z., Fan, Z., Zhao, J., 2020. Prevalence of Insufficient Physical Activity, Sedentary Screen Time and Emotional Well-Being During the Early Days of the 2019 Novel Coronavirus (COVID-19) Outbreak in China: A National Cross-Sectional Study. SSRN Electronic Journal.

Rogers, N., Waterlow, N., Brindle, H., Enria, L., Eggo, R., Lees, S., Roberts, C., 2020. Behavioural change towards reduced intensity physical activity is disproportionately prevalent among adults with serious health issues or self-perception of high risk during the UK COVID-19 lockdown.

Schuch, F.B., Stubbs, B., Meyer, J., Heissel, A., Zech, P., Vancampfort, D., Rosenbaum, S., Deenik, J., Firth, J., Ward, P.B., Carvalho, A.F., Hiles, S.A., 2019. Physical activity protects from incident anxiety: A meta-analysis of prospective cohort studies. Depress Anxiety 36 (9), 846-858.

Schuch, F.B., Vancampfort, D., Firth, J., Rosenbaum, S., Ward, P.B., Silva, E.S., Hallgren, M., Ponce De Leon, A., Dunn, A.L., Deslandes, A.C., Fleck, M.P., Carvalho, A.F., Stubbs, B., 2018. Physical Activity and Incident Depression: A Meta-Analysis of Prospective Cohort Studies. Am J Psychiatry 175 (7), 631-648.

Silva, A., Miranda, D., Diaz, A., Teles, A., Malloy-Diniz, L., Palha, A., 2020. Mental health: why it still matters in the midst of a pandemic. Braz J Psychiatry. 0 (2020).

Smith, L., Jacob, L., Butler, L., Schuch, F., Barnett, Y., Grabovac, I., Veronese, N., Caperchione, C., Lopez-Sanchez, G.F., Meyer, J., 2020. Prevalence and correlates of physical activity in a sample of UK adults observing social distancing during the COVID-19 pandemic. BMJ Open Sport & Exercise Medicine 6 (1), e000850.

Stanton, R., To, Q., Khalesi, S., Williams, S., Alley, S., Thwaite, T., Fenning, A., Vandelanotte, C., 2020. Depression, Anxiety and Stress during COVID-19: Associations with Changes in Physical Activity, Sleep, Tobacco and Alcohol Use in Australian Adults. International journal of environmental research and public health 17, 4065.

Stubbs, B., Koyanagi, A., Schuch, F.B., Firth, J., Rosenbaum, S., Veronese, N., Solmi, M., Mugisha, J., Vancampfort, D., 2016. Physical activity and depression: a large cross‐sectional, population‐based study across 36 low‐and middle‐income countries. Acta Psychiatrica Scandinavica 134 (6), 546-556.

Teychenne, M., Costigan, S.A., Parker, K., 2015. The association between sedentary behaviour and risk of anxiety: a systematic review. BMC Public Health 15, 513.

Teychenne, M., White, R.L., Richards, J., Schuch, F.B., Rosenbaum, S., Bennie, J.A., 2020. Do we need physical activity guidelines for mental health: What does the evidence tell us? Mental Health and Physical Activity 18, 100315.

Wang, C., Pan, R., Wan, X., Tan, Y., Xu, L., Ho, C.S., Ho, R.C., 2020. Immediate psychological responses and associated factors during the initial stage of the 2019 coronavirus disease (COVID-19) epidemic among the general population in China. International journal of environmental research and public health 17 (5), 1729.

Zhai, L., Zhang, Y., Zhang, D., 2015. Sedentary behaviour and the risk of depression: a meta-analysis. Br J Sports Med 49 (11), 705-709.

**Table 1.** Cross-sectional logistic associations of prevalent mental health outcomes with MVPA, VPA, MPA, and SB during COVID-19 pandemic in 2020 in Brazil

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Crude | | | | | | Adj. 1 | | | | | | Adj. 2 | | | | | |
|  | OR | | 95% CI | | p | | OR | | 95% CI | | p | | OR | | 95% CI | | p | |
| MVPA |  | |  | |  | |  | |  | |  | |  | |  | |  | |
| Depression | **0.673** | **0.517** | | **0.877** | | **0.003** | **0.686** | **0.520** | | **0.906** | | **0.008** | **0.718** | **0.537** | | **0.960** | | **0.025** |
| Anxiety | **0.679** | **0.521** | | **0.885** | | **0.004** | **0.697** | **0.531** | | **0.914** | | **0.009** | **0.722** | **0.543** | | **0.962** | | **0.026** |
| Depression and anxiety | **0.657** | **0.496** | | **0.870** | | **0.003** | **0.678** | **0.507** | | **0.907** | | **0.009** | **0.712** | **0.524** | | **0.969** | | **0.031** |
|  |  |  | |  | |  |  |  | |  | |  |  |  | |  | |  |
| VPA |  |  | |  | |  |  |  | |  | |  |  |  | |  | |  |
| Depression | **0.622** | **0.465** | | **0.832** | | **0.001** | **0.606** | **0.447** | | **0.822** | | **0.001** | **0.601** | **0.437** | | **0.826** | | **0.002** |
| Anxiety | **0.698** | **0.523** | | **0.932** | | **0.015** | **0.693** | **0.515** | | **0.932** | | **0.015** | **0.705** | **0.516** | | **0.962** | | **0.027** |
| Depression and anxiety | **0.608** | **0.443** | | **0.834** | | **0.002** | **0.581** | **0.418** | | **0.807** | | **0.001** | **0.591** | **0.418** | | **0.835** | | **0.003** |
|  |  |  | |  | |  |  |  | |  | |  |  |  | |  | |  |
| MPA |  |  | |  | |  |  |  | |  | |  |  |  | |  | |  |
| Depression | **0.736** | **0.565** | | **0.958** | | **0.023** | 0.724 | 0.549 | | 0.956 | | 0.023 | 0.765 | 0.572 | | 1.022 | | 0.070 |
| Anxiety | **0.729** | **0.559** | | **0.949** | | **0.019** | **0.756** | **0.576** | | **0.992** | | **0.043** | 0.753 | 0.566 | | 1.003 | | 0.052 |
| Depression and anxiety | **0.689** | **0.520** | | **0.914** | | **0.010** | **0.712** | **0.531** | | **0.954** | | **0.023** | **0.726** | **0.533** | | **0.989** | | **0.042** |
|  |  |  | |  | |  |  |  | |  | |  |  |  | |  | |  |
| SB |  |  | |  | |  |  |  | |  | |  |  |  | |  | |  |
| Depression | **1.613** | **1.221** | | **2.131** | | **<0.001** | **1.497** | **1.113** | | **2.012** | | **0.008** | **1.396** | **1.025** | | **1.901** | | **0.034** |
| Anxiety | **1.382** | **1.046** | | **1.825** | | **0.032** | 1.266 | 0.948 | | 1.692 | | 0.110 | 1.167 | 0.860 | | 1.583 | | 0.321 |
| Depression and anxiety | **1.639** | **1.225** | | **2.192** | | **0.001** | **1.482** | **1.092** | | **2.013** | | **0.012** | 1.340 | 0.971 | | 1.185 | | 0.075 |

Abbreviations: CI=confidence interval; MPA=moderate physical acvtivity; MVPA=Moderate to vigorous physical activity; OR=odds ratio; SB=Sedentary behavior, VPA=vigorous physical activity.

MVPA: odds of those who perform ≥30 minutes of MVPA/day compared to those that perform less than <30 minutes of MVPA (reference) of having prevalent depressive symptoms (BDI>9), anxiety symptoms (BAI>7), or co-occurring depressive and anxiety symptoms (BDI>9 & BAI>7).

MPA: odds of those who perform ≥30 minutes of MPA/day compared to those that perform less than <30 minutes of MPA (reference) of having prevalent depressive symptoms (BDI>9), anxiety symptoms (BAI>7), or co-occurring depressive and anxiety symptoms (BDI>9 & BAI>7).

VPA: odds of those who perform ≥15 minutes of VPA/day compared to those that perform less than <15 minutes of VPA (reference) of having prevalent depressive symptoms (BDI>9), anxiety symptoms (BAI>7), or co-occurring depressive and anxiety symptoms (BDI>9 & BAI>7).

SB: odds of those who spend ≥10 hours sitting per day compared to those spending <10 hours (reference) of having prevalent depressive symptoms (BDI>9), anxiety symptoms (BAI>7), or co-occurring depressive and anxiety symptoms (BDI>9 & BAI>7).

The models presented are: crude, no adjustments; Adjusted 1 (Adj. 1), adjusted for age, sex, ethnicity, marital status, employment, family income; and Adjusted 2 (Adj. 2), adjusted for age, sex, ethnicity, marital status, employment, family income, days in self-isolation, current smoking, current alcohol consumption, self-reported previous diagnosis of chronic diseases, self-reported previous diagnosis of psychiatric disorders, SB (continuous, for physical activity models) and MVPA (continuous, for SB models).

**Supplementary table 1.** Sample characteristics: overall and stratified by MVPA and SB levels.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Category | Overall N=937\* (%) | Time spent in MVPA per day | | Time spent in SB per day | |
| <30 minutes N=437 (46.6%) | ≥30 minutes N=500 (53.4%) | <10 hours  N=623 (66.7%) | ≥10 hours  N=311 (33.3%) |
| Sex | Male | 258 (27.7%) | 124 (48.1%) | 134 (51.9%) | 160 (62.3%) | 97 (37.3%) |
| Female | 674 (72.3%) | 311 (46.1%) | 363 (53.9%) | 459 (68.3%) | 213 (31.7%) |
| Age | 18-24 years | 135 (14.4%) | 64 (57.4%) | 71 (52.6%) | 66 (49.3%) | 68 (50.7%) |
| 25-34 years | 358 (38.2%) | 180 (50.3%) | 178 (49.7%) | 223 (62.5%) | 134 (37.5%) |
| 35-44 years | 323 (24.8%) | 114 (49.1%) | 118 (50.9%) | 172 (74.1%) | 60 (25.9%) |
| 45-54 years | 114 (12.2%) | 45 (39.5%) | 69 (60.5%) | 89 (78.1%) | 25 (21.9%) |
| 55-64 years | 81 (8.6%) | 31 (38.3%) | 50 (61.7%) | 58 (71.6%) | 23 (28.4%) |
| ≥65 years | 17 (1.8%) | 3 (17.7%) | 14 (82.3%) | 15 (93.7%) | 1 (6.3%) |
| Ethnicity | Asian | 4 (0.4%) | 0 (0%) | 4 (100%) | 4 (100%) | 0 (0%) |
| Black | 28 (3.0%) | 13 (46.4%) | 15 (53.6%) | 17 (63.0%) | 10 (37.0%) |
| Mixed | 174 (18.6%) | 100 (57.5%) | 74 (42.5%) | 118 (68.2%) | 55 (31.8%) |
| Caucasian | 710 (76.0%) | 323 (44.1%) | 397 (55.9%) | 468 (66.0%) | 241 (34.0%) |
| Others | 18 (1.9%) | 10 (55.6%) | 8 (44.4%) | 13 (72.2%) | 5 (27.8%) |
| Marital Status | Married | 391 (42.2%) | 192 (49.1%) | 199 (50.9%) | 283 (72.4%) | 108 (27.6%) |
| Widowed | 4 (0.4%) | 2 (50.0%) | 2 (50.0%) | 3 (75.0%) | 1 (25.0%) |
| Divorced | 68 (7.3%) | 27 (39.7%) | 41 (60.3%) | 50 (74.6%) | 17 (25.4%) |
| Single | 464 (50.1%) | 212 (49.0%) | 252 (54.3%) | 279 (60.4%) | 183 (39.6%) |
| Employment | Employed | 469 (50.1%) | 222 (47.3%) | 247 (52.7%) | 316 (67.5%) | 152 (35.5%) |
| Unemployed | 49 (5.2%) | 24 (49.1%) | 25 (51.0%) | 36 (73.4%) | 13 (26.6%) |
| Student | 246 (26.3%) | 124 (50.4%) | 122 (49.6%) | 144 (58.8%) | 101 (41.2%) |
| Military | 20 (2.1%) | 12 (60.0%) | 8 (40%) | 14 (70.0%) | 6 (30.0%) |
| Self-employed | 124 (13.2%) | 47 (37.9%) | 77 (62.1%) | 316 (67.5%) | 152 (32.5%) |
| Retired | 28 (3.0%) | 8 (28.6%) | 20 (71.4%) | 23 (85.1%) | 4 (14.9%) |
| Monthly household income | <R$1254 (very low income) | 35 (3.7%) | 15 (42.9%) | 20 (57.1%) | 22 (62.9%) | 13 (37.1%) |
| R$1255-R$2004 (low income) | 97 (10.4%) | 50 (51.5%) | 47 (48.5%) | 57 (58.8%) | 40 (41.2%) |
| R$2005-R$8640 (middle income) | 390 (41.7%) | 182 (46.7%) | 208 (53.3%) | 255 (65.6%) | 134 (34.4%) |
| R$8641-R$11261 (high income) | 142 (15.2%) | 74 (52.1%) | 68 (47.9%) | 95 (66.9%) | 47 (33.1%) |
| >R$11262 (very high income) | 272 (29.1%) | 116 (52.6%) | 156 (57.4%) | 193 (71.5%) | 77 (28.5%) |
| Current smoking | No | 889 (94.9%) | 411 (46.2%) | 478 (53.8%) | 590 (66.6%) | 296 (33.4%) |
| Yes | 48 (5.1%) | 26 (54.2%) | 22 (45.8%) | 33 (68.8%) | 15 (31.3%) |
| Current alcohol consumption | No | 291 (31.2%) | 134 (46.0%) | 157 (54.0%) | 203 (69.8%) | 99 (30.2%) |
| Yes | 643 (68.8%) | 300 (46.7%) | 343 (53.3%) | 419 (65.3%) | 223 (34.7%) |
| Day in self-isolation | Median (IQR) | 28.00 (8.00) | 28.00 (8.00) | 28.00 (7.00) | 28.00 (8.00) | 27.00 (8.00) |
| Time spent in MVPA (in minutes per day) | Median (IQR) | 30.00 (60.00) | 0.00 (0.00) | 60.00 (80.00) | 30.00 (80.00) | 20.00 (60.00) |
| Time spent in VPA (in minutes per day) | Median (IQR) | 0.00 (30.00) | 0.00 (0.00) | 20.00 (40.00) | 0.00 (30.00) | 0.00 (15.00) |
| Time spent in MPA (in minutes per day) | Median (IQR) | 20.00 (60.00) | 0.00 (0.00) | 60.00 (30.00) | 30.00 (60.00) | 10.00 (30.00) |
| Time spent in SB (in hours per day) | Median (IQR) | 10.00 (5.00) | 9.00 (5.00) | 10.00 (4.00) | 8.00 (4.00) | 12.00 (3.00) |
| Self-reported lifetime diagnoses of physical conditions | No | 57 (6.1%) | 36 (63.2%) | 21 (36.8%) | 36 (63.2%) | 21 (36.8%) |
| Yes | 877 (93.9%) | 479 (54.4%) | 401 (45.6%) | 587 (66.9%) | 290 (33.1%) |
| Self-reported lifetime diagnoses of psychiatric conditions | No | 553 (59.0%) | 244 (44.1%) | 309 (55.9%) | 383 (69.5%) | 168 (30.5%) |
| Yes | 383 (41.0%) | 193 (50.3%) | 191 (49.7%) | 240 (62.7%) | 143 (37.3%) |
| BAI | Median (IQR) | 6.00 (11.00) | 7.00 (11.00) | 5.00 (9.00) | 5.00 (10.00) | 7.00 (12.00) |
| BDI | Median (IQR) | 9.00 (10.00) | 9.00 (10.00) | 8.00 (8.00) | 8.00 (8.00) | 10.00 (12.00) |

Abbreviations: BAI=Beck Anxiety Inventory; BDI=Beck Depression Inventory; IQR=Interquartile range; MPA= moderate physical activity; MVPA=Moderate to vigorous physical activity; SB=sedentary behavior; VPA=vigorous physical activity. \* Total sample with available data. Number of cases can be different for each variable due to missing cases (minimum=927)

**Supplementary table 2.** Cross-sectional linear associations of mental health outcomes with MVPA, VPA, MPA, and SB during COVID-19 pandemic in 2020 in Brazil

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Crude | | | | Adj. | | | | Adj. 2 | | | |
|  | B | 95% CI | | p | B | 95% CI | | p | B | 95% CI | | p |
| MVPA |  |  |  |  |  |  |  |  |  |  |  |  |
| BDI scores | **-0.099** | **-0.165** | **-0.032** | **0.004** | **-0.071** | **-0.132** | **-0.004** | **0.036** | -0.034 | -0.096 | 0.028 | 0.281 |
| BAI scores | **-0.115** | **-0.196** | **-0.034** | **0.006** | **-0.082** | **-0.163** | **-0.004** | **0.038** | -0.054 | -0.132 | 0.023 | 0.166 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| VPA |  |  |  |  |  |  |  |  |  |  |  |  |
| BDI scores | **-0.263** | **-0.424** | **-0.102** | **0.001** | **-0.233** | **-0.381** | **-0.082** | **0.002** | **-0.188** | **-0.335** | **-0.041** | **0.012** |
| BAI scores | **-0.292** | **-0.488** | **-0.095** | **0.004** | **-0.251** | **-0.442** | **-0.062** | **0.009** | **-0.217** | **-0.400** | **-0.034** | **0.020** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| MPA |  |  |  |  |  |  |  |  |  |  |  |  |
| BDI scores | **-0.104** | **-0.197** | **-0.011** | **0.029** | -0.370 | -0.140 | 0.040 | 0.244 | -0.001 | -0.088 | 0.085 | 0.975 |
| BAI scores | **-0.126** | **-0.024** | **-0.001** | **0.029** | -0.450 | -0.190 | 0.030 | 0.167 | -0.031 | -0.139 | 0.077 | 0.570 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| SB |  |  |  |  |  |  |  |  |  |  |  |  |
| BDI scores | **0.362** | **0.261** | **0.504** | **<0.001** | **0.269** | **0.151** | **0.387** | **<0.001** | **0.221** | **0.104** | **0.338** | **<0.001** |
| BAI scores | **0.325** | **0.178** | **0.471** | **<0.001** | **0.236** | **0.089** | **0.384** | **0.002** | **0.167** | **0.021** | **0.313** | **0.025** |

Abbreviations: B=Beta coefficient; BAI=Beck Anxiety Inventory; BDI=Beck Depression Inventory; CI= Confidence Interval; MPA=moderate physical activity per 10 minutes, MVPA=Moderate to vigorous physical activity per 10 minutes; SB=Sedentary Behavior per hour, VPA=vigorous physical activity per 10 minutes.

The models presented are: crude, no adjustments; Adjusted 1 (Adj. 1), adjusted for age, sex, ethnicity, marital status, employment, family income; and Adjusted 2 (Adj. 2), adjusted for age, sex, ethnicity, marital status, employment, family income, days in self-isolation, current smoking, current alcohol consumption, self-reported previous diagnosis of chronic diseases, self-reported previous diagnosis of psychiatric disorders, SB (for MVPA models) and MVPA (for SB models).