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

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

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Abstract

Objective: To evaluate the associations of moderate to vigorous physical activity (MVPA), vigorous physical activity (VPA), moderate physical activity (MPA), and sedentary behavior (SB) with depressive, anxiety, and co-occurring depressive and anxiety symptoms (D&A) during the COVID-19 pandemic in Brazil.

Methods: Cross-sectional online survey in self-isolating people. Self-reported MVPA, VPA, MPA, and SB (exposures), and depressive and anxiety symptoms (Beck Depression and Anxiety Inventories [BDI and BAI]) were collected. Associations of MVPA, VPA, MPA, and SB with prevalent depressive (BDI>9), anxiety (BAI>7), and D&A (BDI>9+BAI>7) symptoms were investigated using logistic regressions, presented as odds ratio (OR) and 95% confidence interval (95%CI). Linear regressions were performed testing associations with symptom severity. Models were adjusted for confounding factors.

Results: Participants (n=937, females=72.3%) performing ≥30 min/day MVPA or ≥15 min/day VPA had lower odds of prevalent depressive (OR_{MVPA}=0.71, 95%CI=0.53-0.96; OR_{VPA}=0.60, 95%CI=0.43-0.82), anxiety (OR_{MVPA}=0.71, 95%CI=0.54-0.96; OR_{VPA}=0.70, 95%CI=0.51-0.96), and co-occurring D&A symptoms (OR_{MVPA}=0.71, 95%CI=0.52-0.96; OR_{VPA}=0.59, 95%CI=0.41-0.83). People spending ≥10 h/day sedentary were more likely to have depressive symptoms (OR=1.39,95%CI=1.02-1.90). Each hour spent sedentary corresponded to 0.22 (95%CI=0.10-0.33) points and 0.16 (95%CI=0.02-0.31) points higher on the BDI and BAI, respectively.

Conclusion: Higher MVPA and VPA levels are associated with lower odds of depressive, anxiety and D&A symptoms. Higher SB is associated with higher odds of depressive symptoms.

Key Words: Anxiety, COVID-19, Depression, Physical Activity, Sedentary Behaviour, Self-Isolation.

Introduction

The coronavirus disease 2019 (COVID-19) pandemic, caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), is a global public health emergency. Up to the 13th of May, over 4 million cases and 280 thousand deaths worldwide were reported[1]. In Brazil, to that date, over 160 thousand cases and 11 thousand deaths have been notified[1]. To decrease the spread of the SARS-CoV-2 virus, the World Health Organization (WHO) recommended the adoption of physical distancing measures by national governments[1]. In Brazil, the epidemiological report number 05 of the Ministry of Health has proposed social distancing measures, including self-isolation for areas with community transmission[2]. Self-isolation measures are deemed to limit the circulation of the individual in society, thus limiting contact with other individuals. During self-isolation in Brazil, there is a "stay at home" recommendation, asking people going out in public only for essential activities, such as going to the supermarkets or pharmacies or to use essential services for subsistence, such as medical assistance. Yet the national recommendation is to stay at home, each one of the 27 federative units of Brazil can decide about the adoption and implementation of more restrictive measures (quarantine/lockdown).

Prediction models suggest that the early implementation of physical distancing would result in averting almost 90,000 deaths in the largest metropolitan area in Brazil[3]. While self-isolation measures are necessary to reduce the infection rate[4], those measures, together with the "pandemic fear"[5, 6] might be associated with a negative burden on mental health, possibly increasing depressive and anxiety symptoms[7, 8]. Therefore, strategies to mitigate the present and future impact of this mental health burden are necessary[9].

A substantial body of evidence suggests that regular moderate to vigorous physical activity (MVPA), defined as any bodily movement produced by skeletal muscles that require energy expenditure[10] performed at moderate or vigorous intensities, is associated with a lower

prevalence of depressive[11, 12] and anxiety symptoms[12, 13] in the general population, including low-middle income countries. Also, MVPA is linked to a lower likelihood of incident depression and anxiety globally[14, 15]. On the other hand, high levels of sedentary behavior (SB), defined as any waking behaviour characterized by an energy expenditure ≤1.5 METs while in a sitting, reclining or lying posture[16], are associated with an increased risk of depressive[17, 18] and anxiety symptoms[19].

Physical distancing and self-isolation measures result in reduced opportunities for MVPA practice since stadiums, parks, and gyms are closed. Moreover, multiple leisure activities available for those in self-isolation at home include sedentary activities, such as watching television, and seated computer activities. Given the potential influence of the COVID-19 crisis on lifestyle behaviours, depressive and anxiety symptoms, and the known association between depressive and anxiety symptoms, it is essential to understand the potential relationship between MVPA and SB with depressive/anxiety symptoms in the context of COVID-19.

To the best of our knowledge, no study has evaluated the associations between MVPA, and SB with depressive, anxiety, and co-occurring depressive and anxiety (D&A) symptoms during the COVID-19 pandemic. The present study aimed to 1) examine levels of MVPA, and SB during the COVID-19 pandemic in Brazil; 2) examine the presence of depressive, anxiety, and D&A symptoms in Brazil; 3) explore associations between MVPA, and SB with depressive, anxiety, and D&A symptoms; and 4) explore associations of different intensities (vigorous physical activity [VPA] or moderate physical activity [MPA]) with depressive, anxiety, and co-occurring D&A symptoms.

Methods

This paper presents data from 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).

Participants were recruited through social media 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. Participants were directed to an encrypted data website (www.qualtrics.com) where they indicated their consent to participate after reading an information sheet.

Variables

Co-primary outcomes

The co-primary outcomes were symptoms of depression and anxiety and/or these co-occurring together.

Depressive symptoms

Depressive symptoms were assessed using the Beck Depression Inventory (BDI). The BDI is composed of 21 items. Each item consists of a series of four statements based on the severity of depressive symptoms. The score of each item varies from 0 (minimum score) to 3 maximum score). The overall score of the instrument range from 0 to 63. Scores ranging from 0-9 indicate minimal/no depressive; 10-18 indicate mild to moderate depressive symptoms; 19-29 indicate moderate to severe depressive symptoms, and 30-63 indicate severe depressive

symptoms[20]. For this study, depression was dichotomized into no depressive symptoms (0-9) or prevalent depressive symptoms (10-63)[20].

Anxiety symptoms

Anxiety symptoms were assessed using the Beck Anxiety Inventory (BAI). The BAI is composed of 21 items. Each item consists of a different anxiety symptom in which the participant scores how he/she felt in relation to that symptom during the last month, on a scale that varies from 0 (Not at all) to 3 (Severely, it bothered me a lot). The overall scores range from 0 to 63. Scores ranging from 0-7 indicate minimal/no anxiety symptoms; 8-15 indicate mild anxiety symptoms; 16-25 indicate moderate anxiety symptoms, and 26-63 indicate severe anxiety symptoms[21]. For the study purpose, anxiety was dichotomized into absent anxiety symptoms (0-7) or prevalent anxiety symptoms (8-63)[21].

Co-occurring depressive and anxiety (D&A) symptoms

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

Exposures

Moderate to Vigorous Physical Activity (MVPA)

Time spent in MVPA was assessed by two questions: 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?”. The questions were accompanied by the following explanations: “Think about all the vigorous and

moderate activities that you do on average daily during self-isolating. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal". For the logistic models, MVPA, moderate physical activity (MPA), and vigorous physical activity (VPA) when self-isolating were treated as dichotomous variables. MVPA and MPA were dichotomized into 1 = <30 minutes per day, or 2 = ≥30 minutes per day. VPA was dichotomized into 1 = <15 minutes per day, or 2 = ≥15 minutes of VPA per day). These cut-offs were chosen to be in line with the public health recommendations of 150 minutes of MVPA, or 75 minutes of VPA per week[22].

Sedentary Behavior (SB)

Time spent in SB was assessed using the question: "Since self-isolating, how much time have you spent sitting daily?". SB was treated as a dichotomous variable (1= <10 hours spent sitting per day; 2 = ≥10 hours or more spent sitting per day), as used in previous studies[23, 24].

Covariates

Demographic data were collected, including sex (male or female), age (in 10-year age bands), ethnicity (asian, black, caucasian, mixed, other), marital status (single, separated/divorced, widowed or married/in a domestic partnership), employment (Unemployed, Student, Military, Self-employed or Retired), and household income (i.e., <R$1254, R$1255-R$2004, R$2005-R$8640, R$8641-R$11261, >R$11262), 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. Substance consumption, such as current smoking status (yes or no), and current alcohol consumption (yes or no) were evaluated. Self-reported previous diagnosis of chronic physical conditions (e.g.: obesity, hypertension, myocardial infarction,

angina pectoris and other coronary diseases, other cardiac diseases, varicose veins of lower extremities, osteoarthritis, chronic neck pain, chronic low back pain, chronic allergy [excluding allergic asthma], asthma [including allergic asthma], chronic bronchitis, emphysema or chronic obstructive pulmonary disease [COPD], type 1 diabetes, type 2 diabetes, diabetic retinopathy, cataract, peptic ulcer disease, urinary incontinence or urine control problems, hypercholesterolaemia, chronic skin disease, chronic constipation, liver cirrhosis and other hepatic disorders, stroke, chronic migraine and other frequent chronic headaches, haemorrhoids, cancer, osteoporosis, thyroid disease, renal disease, and injuries), as well as, previous diagnosis of psychiatric conditions (e.g.: depression, anxiety, bipolar disorder, schizophrenia or others) were also evaluated through self-reported questions. For these questions, a list with all the above-mentioned conditions was shown.

Statistical analyses

Sample characteristics were displayed for the whole overall sample and stratified according to the time spent in MVPA (≥30 minutes vs. <30 minutes per day), and time spent in SB (<10 hours vs. ≥10 hours per day). 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 differences in the median depressive and anxiety symptoms between MVPA or SB levels were tested using Mann-Whitney U tests. The associations between MVPA or SB with the prevalence of symptoms of mental health outcomes (depressive, anxiety, or D&A) were tested with models of logistic regressions and 95% CI. We also tested the associations across different intensities (VPA and MPA) with prevalent depressive, anxiety, and co-occurring D&A symptoms. First, the models were tested without adjustments (crude). Second, the models were adjusted for age (categoric, 10-year age band) and sex (men/women) (adjusted 1). Third, the models were adjusted for age, sex,

ethnicity (categoric), marital status (categoric), family income (categoric), days in self-isolation (continuous), current smoking (yes/no), current alcohol consumption (yes/no), previous diagnosis of chronic diseases (yes/no), previous diagnosis of psychiatric disorders (yes/no), time spent sitting per day (continuous; for MVPA, VPA and MPA models) or time spent in MVPA (continuous; for SB models) (adjusted 2). Results from the logistic regression analysis are presented as odds ratios (ORs) and 95% confidence intervals (CIs). The adjusted mean differences (AMD) in depressive and anxiety symptoms according to MVPA (≥30 minutes vs. <30 minutes per day) or SB (≥10 hours vs. <10 hours per day) levels were calculated using analyses of covariance (ANCOVAS), adjusting for the same variables used in the logistic regression models. Linear regressions were performed using continuous data for MVPA, VPA, MPA, SB, and depressive and anxiety symptoms. Models tested for linear regressions were the same used in logistic models. We adopted a statistical significance level at $p < 0.05$. The statistical analysis was performed with SPSS version 22.0 (IBM Corporation).

Results

A total of 937 adults were included in the study. The sample was predominantly composed by women (72.3%), young adults (52.6%) of participants aged 18-35 years, Caucasians (76.0%), singles (50.1%), currently employed (50.1%), with a monthly household income ranging from R$2005-R$11261 (56.9%). Most participants were non-smokers (94.9%) but were consuming alcoholic beverages during the self-isolation (68.8%). The overall cohort reported engaging in a median of 30 (IQR=60.00) minutes of MVPA per day, and spending an median of 10.0 (IQR=5.0), hours per day in SB. A total of 500 participants (53.4%) spent ≥30 minutes of MVPA per day, and 311 (33.3%) spent ≥10 hours in SB per day. The prevalence of self-reported previous diagnosis of chronic physical conditions (any disease) was 93.3%. The prevalence of self-reported previous diagnosis of psychiatric disorders (any disorder) was

41.0% (depression=20.0%, any anxiety disorder=24.4%, bipolar disorder=2.0%, schizophrenia or other psychotic disorders=0.1%). The full details of the overall sample, and according to the time spent in MVPA and SB are detailed in table 1.

The median of depressive symptoms in the overall sample was 9.00 (IQR=10.00), mean=9.98 (7.60), points in the BDI scale. Those that reported ≥30 minutes in MVPA per day reported lower depressive symptoms than those that spent <30 minutes per day in MVPA (AMD= -0.707; 95%CI= -1.160 to -0.253, p=0.002). Also, those that spent <10 hours in SB per day reported lower depressive symptoms than those that spent ≥10 hours in SB per day (AMD= -1.736, 95%CI= -2.704 to -0.768, p<0.001).

The median of anxiety symptoms in the overall sample was 6.00 (IQR=11.0), mean =9.01 (9.12) points in the BAI score scale. Those that spent ≥30 minutes in MVPA reported lower anxiety symptoms than those that spent <30 minutes per day in MVPA (AMD= -0.759; 95%CI= -1.312 to -0.206, p=0.007). Also, those that spent <10 hours in SB per day reported lower anxiety symptoms than those that spent ≥10 hours in SB per day (AMD= -1.665; 95%CI= -2.869 to -0.461, p=0.007).

The prevalence of symptoms of depressive, anxiety, and D&A in the cohort were 43.6%, 43.3%, and 31.9%, respectively. The prevalence of depressive, anxiety, and comorbid D&A symptoms, per MVPA and SB group can be seen in figure 1.

Those reporting ≥30 minutes in MVPA 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 when adjusting for potential covariates. Those spending ≥10 hours per day in SB were more likely to present prevalent depressive symptoms (OR=1.39, 95%CI=1.02-1.90) in the most adjusted analyses. The detailed results of the logistic regression models are presented in table 2. Linear associations, adjusting for relevant covariates, demonstrate that each hour spent in SB is associated with 0.22 points higher on the

BDI (95%CI=0.104-0.338) and 0.16 points higher at the BAI (95%=CI=0.021-0.313). The linear models for MVPA and SB are shown in table 3.

When we look across different MVPA intensities, spending ≥15 minutes per day in VPA is associated with lower odds of prevalent 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 per day in MPA is associated with a lower prevalence of co-occurring D&A symptoms (OR=0.72, 95%CI=0.53-0.98) (Table 4). Linear regression models found that every 10 minutes spent in VPA is associated with 0.18 (95%CI=0.041-0.335) points lower on the BDI, and -0.21 (95%CI=0.034-0.400) points lower on the BAI scales, respectively (table 5).

Discussion

This is, to the best of our knowledge, the first study assessing the association between MVPA, VPA, MPA, and SB and prevalent depressive, anxiety, and co-occurring D&A symptoms among self-isolating adults during the COVID-19 pandemic. In the present study, nearly half of participants reported performing ≥30 minutes MVPA per day, and one third reported spending ≥10 hours in SB per day. The prevalence of depressive and anxiety symptoms was approximately 40%, while one third reported co-occurring D&A and anxiety symptoms. We observed a relationship suggesting that people reporting ≥30 minutes in MVPA per day were approximately 30% less likely to present depressive, anxiety, and D&A symptoms, even when we adjust for relevant covariates. Those reporting ≥15 minutes of VPA per day were approximately 40% less likely to present with prevalent depressive and D&A symptoms, and 30% less likely to present prevalent anxiety symptoms. Those spending ≥10 hours a day in SB were 39% more likely to present prevalent depressive symptoms in the adjusted models.

The present study found a high prevalence of depressive, anxiety, and comorbid D&A symptoms in a sample of the Brazilian population during COVID-19 pandemic. Although the average severity of depressive and anxiety symptoms of the sample falls within the range of mild symptoms, the prevalence of depressive symptoms is about four times higher than those found in previous studies in Brazil using similar screening tools[25]. Other studies also found high prevalences of depressive and anxiety symptoms in the general population during the COVID-19 pandemics in Paraguay (depression=59.6%, anxiety=47.2%)[26], Turkey (moderate to severe depression=18.6%, moderate to severe anxiety=26.5%)[27], China (depression=48.1%, anxiety=22.6%, D&A=19.4%)[8], and Basque region of Spain (depression=20.8%, anxiety=29.0%). Our study is not representative of the general population and the results should be interpreted taking the potential for self-selection bias into account, also, we have used a screening tool that is not able to diagnose depressive or anxiety disorders[25] . However, the high prevalence of symptoms found is suggestive that the pandemic and the self-isolation are impacting mental health[5, 6]. Accordingly, epidemiological studies to precisely estimate the real mental health burden in the population are required. In the meanwhile, even not being representative, and potentially overestimated, the findings indicate that governing bodies should take initiatives to reduce the mental health burden during periods that the general population is requested to isolate themselves.

In the early days of the COVID-19 outbreak in China, a cross-sectional study found that nearly 60% of participants did not meet the PA recommendations (<150 minutes of MVPA per week). Moreover, they have found an association of PA levels with fewer negative affect[28]. Our findings are in line with the association found in China, suggesting that over 30 minutes of daily MVPA is associated with reduced co-occurring depressive and anxiety symptoms. In our study, 15 minutes or over of VPA per day was associated with a lower prevalence of depressive, anxiety, and co-occurring D&A symptoms. Also, we found a linear association with depressive

and anxiety symptoms severity, suggesting a dose-response association. However, no linear associations were seen in the present study between MPA or MVPA with depressive and anxiety symptoms when we adjust for covariates. A potential explanation is that during the pandemics, time spent in MPA might be heavily influenced by time spent in household activities as most household activities fall within this intensity range[29]. In turn, VPA might more closely reflect leisure-time physical activity. According to previous evidence, leisure-time PA is more likely to be associated with positive mental health outcomes[12] than household activities and those expending long periods in household activities might not be experiencing the same benefits.

We found significant associations between increased time spent in SB and depression and anxiety symptom severity when adjusting for covariates such as time spent in MVPA. Moreover, those spending over 10 hours in SB per day were more likely to present prevalent depressive, but not anxiety or co-occurring D&A symptoms[18, 30]. This difference might be explained by the fact that periods longer than 10 hours per day of SB are needed to impact significantly in the presence of significant anxiety symptoms[17].

While our data are cross-sectional and directionality is unclear, previous longitudinal[14, 15], mendelian randomisation[31] and randomised trials[32] support the notion that MVPA protects against and improves depressive and anxiety symptoms. Assuming that MVPA is protective against depressive and anxiety symptoms, these effects can be explained by some underlying mechanisms. First, MVPA can increase the release of endocannabinoids, which has antidepressant and anxiolytic effects[33]. Second, MVPA improves neuroplasticity and functions on the brain, reflected by the increase of neurotrophic factors, such as brain-derived neurotrophic factors (BDNF)[34]. The changes in BDNF levels seem to be associated with the antidepressant effects of exercise[35]. Third, evidence suggests that MVPA can fortify the anti-inflammatory and antioxidant systems, which are increased in depressive and anxiety

disorders[36]. On the other hand, randomized controlled trials have demonstrated that inducing SB increases depressive symptoms, and this effect is partially mediated by an increase in inflammatory markers[37]. Fourth, there is a large body of literature about the risks of infection, casualties and other anxiogenic content available being consumed during the self-isolation[38], so the time spent in MVPA can also work as a distraction when participants are focusing in the activity, and not ruminating that specific information. Fifth, psychosocial mechanisms including social connectivity may be key mechanisms that contribute to the antidepressant effect of exercise. For example, those who are more physically active may engage in more social interaction when participating in group exercise classes as using social media/online social interaction is associated with positive affect during the COVID-19 pandemic[39]. Lastly, a body of evidence suggests that there is a bidirectional relationship between MVPA and SB with depressive symptoms and anxiety, so it is expected that people with depressive and anxiety symptoms are less likely to be active and more sedentary[40].

Strategies to promote MVPA practice should be adapted to this context, in terms of both the current response to COVID-19 and the amelioration of it's future impacts on mental health. Besides, exercise seems to reduce the severity of acute respiratory symptoms in the general population[41], however, there is yet no study evaluating the protective effects or safety of exercise in people with COVID-19 infection. At this moment, we suggest that exercise professionals should be alert to the potential signs of COVID-19 infection. Therefore, a brief screening of COVID-19 symptoms might be necessary before engaging in MVPA[42]. When signs and symptoms of infection are detected, the participant should refrain from MVPA and follow the local health department recommendations.

The present study has some limitations. First, the cross-sectional design does not allow to draw any directionality in the relationship. Further longitudinal data can further clarify the potential protective effects of MVPA against the development of depression and anxiety during

the self-isolation. Second, the sample was mostly composed of females and young adults recruited by social media (Facebook, Instagram, Twitter, and emails sent to a network of researchers. Although there is data of participants from 24 of the 27 Brazilian states, about 62% of participants are from Rio Grande do Sul, 14.8% from Rio de Janeiro, and 6.5% from Ceará states. Therefore, the representativeness of this sample is limited. 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), causing an exaggerated prevalence. Fourth, all data was collected using a self-report online survey. Self-reported data can suffer from recall bias, as well as, by social desirability. Last, we could not explore whether PA was performed during leisure-time or in other domains. Further studies should evaluate the role of the different domains that PA is performed in the associations between MVPA and depressive and anxiety during COVID-19 pandemic.

Conclusion

People engaged in higher levels of MVPA and VPA are less likely to present depressive, anxiety, and D&A symptoms during self-isolation. Those reporting higher levels of SB are more likely to present prevalent depressive symptoms. Strategies targeting to increase MVPA and VPA and reduce SB at populational levels might be important to mitigate the mental health burden during the COVID-19 pandemics. Public health recommendations should make clear to the general population how to exercise safely.

Acknowledgments

This study was part financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001. Joseph Firth is supported by a University of Manchester Presidential Fellowship (P123958) and a UK Research and Innovation Future

Leaders Fellowship (MR/T021780/1). Brendon Stubbs is supported by a Clinical Lectureship (ICA-CL-2017-03-001) jointly funded by Health Education England (HEE) and the National Institute for Health Research (NIHR). Brendon Stubbs is part funded by the NIHR Biomedical Research Centre at South London and Maudsley NHS Foundation Trust. The views expressed are those of the author(s) and not necessarily those of the (partner organisation), the NHS, the NIHR or the Department of Health and Social Care. Mark Tully is partly supported by funding as Director of the Northern Ireland Public Health Research Network by the Research and Development Division of the Public Health Agency (Northern Ireland).

Authors contributions

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References

1. Organization WH. Coronavirus disease 2019 (COVID-19): situation report, 114. 2020.
2. Saúde Md. Boletim epidemiológico 05 - 20/03/2020. In: Saúde Md, ed. http://maismedicos.gov.br/images/PDF/2020_03_13_Boletim-Epidemiologico-05.pdf; 2020.
3. Ganem F, Mendes FM, Oliveira SB, et al. The impact of early social distancing at COVID-19 Outbreak in the largest Metropolitan Area of Brazil. *medRxiv.* 2020:2020.2004.2006.20055103.
4. Bedford J, Enria D, Giesecke J, et al. COVID-19: towards controlling of a pandemic. *The Lancet.* 2020;395(10229):1015-1018.

5. Silva A, Miranda D, Diaz A, Teles A, Malloy-Diniz L, Palha A. Mental health: why it still matters in the midst of a pandemic. *Braz J Psychiatry.* 2020;0(2020).
6. Ornell F, Schuch JB, Sordi AO, Kessler FHP. Pandemic fear and COVID-19: mental health burden and strategies. *Brazilian Journal of Psychiatry.* 2020.
7. Brooks SK, Webster RK, Smith LE, et al. The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *The Lancet.* 2020.
8. Wang C, Pan R, Wan X, et al. Immediate psychological responses and associated factors during the initial stage of the 2019 coronavirus disease (COVID-19) epidemic among the general population in China. *Int J Environ Res Public Health.* 2020;17(5):1729.
9. Holmes EA, O'Connor RC, Perry VH, et al. Multidisciplinary research priorities for the COVID-19 pandemic: a call for action for mental health science. *The Lancet Psychiatry.* 2020/04/15/ 2020.
10. Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Health Rep.* Mar-Apr 1985;100(2):126-131.
11. Stubbs B, Koyanagi A, Schuch FB, et al. Physical activity and depression: a large cross-sectional, population-based study across 36 low-and middle-income countries. *Acta Psychiatrica Scandinavica.* 2016;134(6):546-556.
12. Teychenne M, White RL, Richards J, Schuch FB, Rosenbaum S, Bennie JA. Do we need physical activity guidelines for mental health: What does the evidence tell us? *Mental Health and Physical Activity.* 2020;18:100315.
13. Stubbs B, Koyanagi A, Hallgren M, et al. Physical activity and anxiety: A perspective from the World Health Survey. *J Affect Disord.* Jan 15 2017;208:545-552.
14. Schuch FB, Stubbs B, Meyer J, et al. Physical activity protects from incident anxiety: A meta-analysis of prospective cohort studies. *Depression and anxiety.* Sep 2019;36(9):846-858.
15. Schuch FB, Vancampfort D, Firth J, et al. Physical Activity and Incident Depression: A Meta-Analysis of Prospective Cohort Studies. *Am J Psychiatry.* Jul 1 2018;175(7):631-648.
16. Tremblay MS, Aubert S, Barnes JD, et al. Sedentary behavior research network (SBRN)–terminology consensus project process and outcome. *International Journal of Behavioral Nutrition and Physical Activity.* 2017;14(1):75.
17. Hallgren M, Owen N, Vancampfort D, et al. Associations of sedentary behavior in leisure and occupational contexts with symptoms of depression and anxiety. *Preventive medicine.* 2020;133:106021.
18. Zhai L, Zhang Y, Zhang D. Sedentary behaviour and the risk of depression: a meta-analysis. *Br J Sports Med.* Jun 2015;49(11):705-709.
19. Teychenne M, Costigan SA, Parker K. The association between sedentary behaviour and risk of anxiety: a systematic review. *BMC public health.* Jun 19 2015;15:513.
20. Beck AT, Ward CH, Mendelson M, Mock J, Erbaugh J. An inventory for measuring depression. *Arch Gen Psychiatry.* Jun 1961;4:561-571.
21. Beck AT, Epstein N, Brown G, Steer RA. An inventory for measuring clinical anxiety: psychometric properties. *J Consult Clin Psychol.* Dec 1988;56(6):893-897.
22. Organization WH. *Global recommendations on physical activity for health*: World Health Organization; 2010.

23. Ellingson LD, Meyer JD, Shook RP, et al. Changes in sedentary time are associated with changes in mental wellbeing over 1 year in young adults. *Prev Med Rep.* Sep 2018;11:274-281.
24. Gibson A-M, Muggeridge D, Hughes A, Kelly L, Kirk A. An examination of objectively-measured sedentary behavior and mental well-being in adults across week days and weekends. *PloS one.* 09/21 2017;12:e0185143.
25. Silva MT, Galvao TF, Martins SS, Pereira MG. Prevalence of depression morbidity among Brazilian adults: a systematic review and meta-analysis. *Brazilian Journal of Psychiatry.* 2014;36:262-270.
26. Rios-González C, Palacios J. *Symptoms of Anxiety and depression during the outbreak of COVID-19 in Paraguay*2020.
27. Mustafa N. *Psychological Stress and Associated Factors during the Coronavirus Disease (COVID-19)*2020.
28. Qin F, Song Y, Nassis G, et al. 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.* 01/01 2020.
29. Ainsworth BE, Haskell WL, Herrmann SD, et al. 2011 Compendium of Physical Activities: A Second Update of Codes and MET Values. *Medicine & Science in Sports & Exercise.* 2011;43(8).
30. Hallgren M, Owen N, Stubbs B, et al. Passive and mentally-active sedentary behaviors and incident major depressive disorder: a 13-year cohort study. *Journal of affective disorders.* 2018;241:579-585.
31. Choi KW, Chen CY, Stein MB, et al. Assessment of Bidirectional Relationships Between Physical Activity and Depression Among Adults: A 2-Sample Mendelian Randomization Study. *JAMA Psychiatry.* Apr 1 2019;76(4):399-408.
32. Ashdown-Franks G, Firth J, Carney R, et al. Exercise as medicine for mental and substance use disorders: A meta-review of the benefits for neuropsychiatric and cognitive outcomes. *Sports Medicine.* 2020;50(1):151-170.
33. Meyer JD, Crombie KM, Cook DB, Hillard CJ, Koltyn KF. Serum Endocannabinoid and Mood Changes after Exercise in Major Depressive Disorder. *Medicine and science in sports and exercise.* 2019;51(9):1909-1917.
34. Kerling A, Kuck M, Tegtbur U, et al. Exercise increases serum brain-derived neurotrophic factor in patients with major depressive disorder. *J Affect Disord.* Jun 2017;215:152-155.
35. Meyer JD, Koltyn KF, Stegner AJ, Kim JS, Cook DB. Relationships between serum BDNF and the antidepressant effect of acute exercise in depressed women. *Psychoneuroendocrinology.* Dec 2016;74:286-294.
36. Köhler CA, Freitas TH, Stubbs B, et al. Peripheral alterations in cytokine and chemokine levels after antidepressant drug treatment for major depressive disorder: systematic review and meta-analysis. *Molecular neurobiology.* 2018;55(5):4195-4206.
37. Endrighi R, Steptoe A, Hamer M. The effect of experimentally induced sedentariness on mood and psychobiological responses to mental stress. *The British journal of psychiatry : the journal of mental science.* Mar 2016;208(3):245-251.
38. Gao J, Zheng P, Jia Y, et al. Mental health problems and social media exposure during COVID-19 outbreak. *PloS one.* 04/16 2020;15:e0231924.

39. Lades L, Laffan K, Daly M, Delaney L. Daily emotional well-being during the COVID-19 pandemic. 2020.

40. Vancampfort D, Firth J, Schuch FB, et al. Sedentary behavior and physical activity levels in people with schizophrenia, bipolar disorder and major depressive disorder: a global systematic review and meta-analysis. *World Psychiatry.* Oct 2017;16(3):308-315.

41. Grande AJ, Keogh J, Silva V, Scott AM. Exercise versus no exercise for the occurrence, severity, and duration of acute respiratory infections. *Cochrane Database of Systematic Reviews.* 2020(4).

42. de Oliveira Neto L, de Oliveira Tavares VD, Schuch FB, Lima KC. Coronavirus Pandemic (SARS-COV-2): Pre-Exercise Screening Questionnaire (PESQ) for Telepresential Exercise. *Front Public Health.* 2020-April-21 2020;8(146).

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	35 (3.7%)	15 (42.9%)	20 (57.1%)	22 (62.9%)	13 (37.1%)
	R$1255-R$2004	97 (10.4%)	50 (51.5%)	47 (48.5%)	57 (58.8%)	40 (41.2%)
	R$2005-R$8640	390 (41.7%)	182 (46.7%)	208 (53.3%)	255 (65.6%)	134 (34.4%)
	R$8641-R$11261	142 (15.2%)	74 (52.1%)	68 (47.9%)	95 (66.9%)	47 (33.1%)
	>R$11262	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 previous diagnoses	No	57 (6.1%)	36 (63.2%)	21 (36.8%)	36 (63.2%)	21 (36.8%)

of physical conditions	Yes	877 (93.9%)	479 (54.4%)	401 (45.6%)	587 (66.9%)	290 (33.1%)
Self-reported previous 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)

Table 2. Cross-sectional logistic associations of prevalent mental health outcomes with MVPA, 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**	**0.700**	**0.532**	**0.921**	**0.011**	**0.718**	**0.537**	**0.960**	**0.025**
Anxiety	**0.679**	**0.521**	**0.885**	**0.004**	**0.702**	**0.535**	**0.920**	**0.011**	**0.722**	**0.543**	**0.962**	**0.026**
Depression and anxiety	**0.657**	**0.496**	**0.870**	**0.003**	**0.684**	**0.512**	**0.914**	**0.001**	**0.712**	**0.524**	**0.969**	**0.031**
SB												
Depression	**1.613**	**1.221**	**2.131**	**<0.001**	**1.486**	**1.108**	**1.993**	**0.008**	**1.396**	**1.025**	**1.901**	**0.034**
Anxiety	**1.382**	**1.046**	**1.825**	**0.032**	1.293	0.967	1.728	0.083	1.167	0.860	1.583	0.321
Depression and anxiety	**1.639**	**1.225**	**2.192**	**0.001**	**1.487**	**1.096**	**2.017**	**0.011**	1.340	0.971	1.185	0.075

Abbreviations: CI confidence interval; MVPA=Moderate to vigorous physical activity; OR odds ratio; SB=Sedentary behavior.
MVPA: odds of those who perform ≥30 minutes of MVPA per day compared to those that perform less than <30 minutes of MVPA (reference) of having prevalent depression symptoms (BDI>9), anxiety symptoms (BAI>7), or co-occurring depression 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 depression symptoms (BDI>9), anxiety symptoms (BAI>7), or co-occurring depression and anxiety symptoms (BDI>9 & BAI>7).
The models presented are: crude, no adjustments; Adjusted 1 (Adj. 1), adjusted for age and sex; 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).

Table 3. Cross-sectional linear associations of mental health outcomes with MVPA, 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**	-0.057	-0.121	0.008	0.085	-0.034	-0.096	0.028	0.281
BAI scores	**-0.115**	**-0.196**	**-0.034**	**0.006**	-0.077	-0.157	0.003	0.058	-0.054	-0.132	0.023	0.166
SB												
BDI scores	**0.362**	**0.261**	**0.504**	**<0.001**	**0.283**	**0.164**	**0.403**	**<0.001**	**0.221**	**0.104**	**0.338**	**<0.001**
BAI scores	**0.344**	**0.195**	**0.493**	**<0.001**	**0.254**	**0.105**	**0.404**	**0.001**	**0.167**	**0.021**	**0.313**	**0.025**

Abbreviations: B=Beta coefficient; BAI= Beck Anxiety Inventory; BDI=Beck Depression Inventory; CI= Confidence Interval; MVPA=Moderate to vigorous physical activity per 10 minutes; SB=Sedentary Behavior per hour.
The models presented are: crude, no adjustments; Adjusted 1 (Adj. 1), adjusted for age and sex; 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).

Table 4. Cross-sectional associations of prevalent mental health outcomes with VPA, and MPA 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
VPA												
Depression	**0.622**	**0.465**	**0.832**	**0.001**	**0.631**	**0.467**	**0.853**	**0.003**	**0.601**	**0.437**	**0.826**	**0.002**
Anxiety	**0.698**	**0.523**	**0.932**	**0.015**	**0.715**	**0.532**	**0.961**	**0.026**	**0.705**	**0.516**	**0.962**	**0.027**
Depression and anxiety	**0.608**	**0.443**	**0.834**	**0.002**	**0.615**	**0.444**	**0.852**	**0.003**	**0.591**	**0.418**	**0.835**	**0.003**
MPA												
Depression	**0.736**	**0.565**	**0.958**	**0.023**	0.761	0.578	1.002	0.052	0.765	0.572	1.022	0.070
Anxiety	**0.729**	**0.559**	**0.949**	**0.019**	**0.746**	**0.569**	**0.980**	**0.035**	0.753	0.566	1.003	0.052
Depression and anxiety	**0.689**	**0.520**	**0.914**	**0.010**	**0.713**	**0.533**	**0.954**	**0.023**	**0.726**	**0.533**	**0.989**	**0.042**

Abbreviations: CI confidence interval; MPA=Moderate physical activity; OR odds ratio; VPA=Vigorous physical activity.
MPA: odds of those who perform ≥30 minutes of MPA per day compared to those that perform less than <30 minutes of MPA (reference) of having prevalent depression symptoms (BDI>9), anxiety symptoms (BAI>7), or co-occurring depression and anxiety symptoms (BDI>9 & BAI>7).
VPA: odds of those who perform ≥15 minutes of VPA per day compared to those that perform less than <15 minutes of VPA (reference) of having prevalent depression symptoms (BDI>9), anxiety symptoms (BAI>7), or co-occurring depression and anxiety symptoms (BDI>9 & BAI>7).
The models presented are: crude, no adjustments; Adjusted 1 (Adj. 1), adjusted for age and sex; 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, and sedentary behavior.

Table 5. Cross-sectional linear associations of mental health outcomes with VPA, and MVPA during COVID-19 pandemic in 2020 in Brazil

	Crude				**Adj. 1**				**Adj. 2**			
	B	95% CI		p	B	95% CI		p	B	95% CI		p
VPA												
BDI Scores	**-0.263**	**-0.424**	**-0.102**	**0.001**	**-0.204**	**-0.357**	**-0.050**	**0.009**	**-0.188**	**-0.335**	**-0.041**	**0.012**
BAI scores	**-0.292**	**-0.488**	**-0.095**	**0.004**	**-0.236**	**-0.427**	**-0.044**	**0.016**	**-0.217**	**-0.400**	**-0.034**	**0.020**
MPA												
BDI scores	**-0.104**	**-0.197**	**-0.011**	**0.029**	-0.041	-0.132	0.049	0.369	-0.001	-0.088	0.085	0.975
BAI scores	**-0.126**	**-0.024**	**-0.001**	**0.029**	-0.071	-0.183	0.041	0.216	-0.031	-0.139	0.077	0.570

Abbreviations: B=Beta coefficient; BAI= Beck Anxiety Inventory; BDI=Beck Depression Inventory; CI=Confidence Interval; MPA=Moderate physical activity per 10 minutes; VPA=Vigorous physical activity per 10 minutes,

The models presented are: crude, no adjustments; Adjusted 1 (Adj. 1), adjusted for age and sex; 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, sedentary behavior.

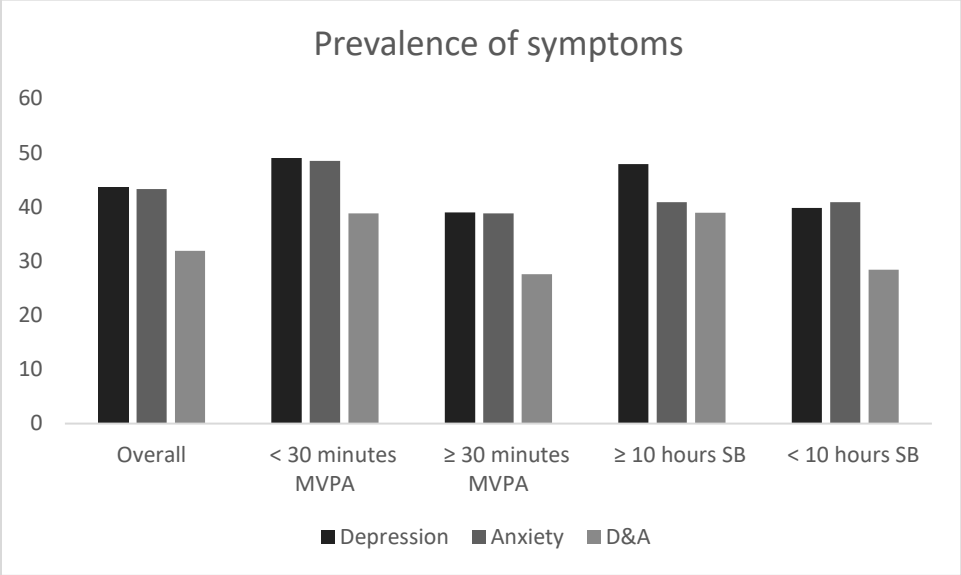

Figure 1. Prevalence of depression (Beck Depression Inventory [BDI] >9), anxiety (Beck Anxiety Inventory [BAI] >7) and comorbid depression and anxiety (D&A) symptoms (BDI>9 and BAI>7) for the overall sample, time spent in moderate to vigorous physical activity (MVPA) per day, and time spent in sedentary behavior (SB) per day.