

## BRIEF COMMUNICATION

# Physical activity and depressive symptoms among adolescents in a school-based sample

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**Objective:** To explore associations between self-reported weekly physical activity and depressive symptomatology among adolescents in a school-based sample from Brazil.

**Methods:** We surveyed 7,405 adolescents aged 14 to 16 years in 101 public schools in Porto Alegre, Brazil. We assessed physical activity using an adapted version of the Patient-Centered Assessment and Counseling for Exercise Plus Nutrition – Adolescent Physical Activity Measure (PACE+), and depressive symptoms using the Brazilian Portuguese version of the Patient Health Questionnaire – Adolescent Version. We compared the depressive symptom scores among adolescents with varying levels of physical activity.

**Results:** Of the overall sample, 84.4% exercised less than the recommended frequency of 60 minutes/day, at least 5 days/week, of moderate to intense physical activity (PACE+ score  $\geq 5$ ). Adolescents whose physical activity levels fell below that threshold had higher median depression scores (8 [IQR = 10] vs. 7 [IQR = 9],  $W = 4060461$ ,  $p < 0.001$ ). A similar pattern was observed for depression scores in those with PACE+  $< 1$  (median of 10 [IQR = 11]) and  $\geq 1$  (7 [IQR = 9],  $W = 7457608$ ,  $p < 0.001$ ).

**Conclusion:** In this large sample of Brazilian adolescents, those who exercised less frequently and vigorously than their peers reported more depressive symptoms.

**Keywords:** Exercise; adolescent; depression

## Introduction

Adolescence is a dynamic developmental period during which biological, cognitive, emotional, and social phenomena lay the groundwork for health in subsequent life stages. It is during adolescence that many risk factors for poor health are established. Conversely, adolescence can be a window of opportunity for preventing negative outcomes by developing habits that can have both individual and intergenerational benefits.<sup>1</sup>

Physical activity is an important habit that counteracts modifiable risk factors, such as sedentarism and obesity. The World Health Organization (WHO)<sup>2</sup> recommends 60 minutes or more of moderate to intense daily physical activity for children and adolescents. However, research indicates that total physical activity levels decrease by approximately 7% each year between 10 and 19 years of

age.<sup>3</sup> Accelerometry data suggest that this decrease might be driven by increasing sedentary behavior and a reduction in light activity throughout adolescence.<sup>3-5</sup> A recent analysis based on multinational surveys (including the Global School-based Student Health Survey and the Health Behavior among School aged Children)<sup>6</sup> reported that 81% of students aged 11-17 years (especially girls) were insufficiently physically active.

The notion of *mens sana in corpore sano* – i.e., the idea that a healthy body and a healthy mind are intertwined – has been recognized since ancient times. Along with the high rate of insufficient physical activity observed worldwide, adolescence also represents a period of elevated incidence of mental disorders.<sup>7</sup> Depression, the psychiatric disorder associated with the greatest global disease burden across the lifecycle, markedly increases during adolescence. Although its prevalence among pre-pubertal

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children is low (around 1%),<sup>8</sup> by 18 years of age approximately 11% of adolescents report having had at least one depressive episode.<sup>9</sup>

In a large school-based sample of adolescents from Brazil, this study investigated the association between the frequency, duration and intensity of self-reported physical activity and self-reported depressive symptomatology and whether this varies between boys and girls.

## Methods

We analyzed cross-sectional data from the screening phase of the Identifying Depression Early in Adolescence Risk Stratified Cohort,<sup>10</sup> part of a multinational collaborative effort for the advancement of early identification of major depressive disorder in adolescence.<sup>11</sup> Between 2018 and 2019, we screened students aged 14 to 16 years who were enrolled in the 8th through 11th grades in 101 public schools in the city of Porto Alegre, Brazil. Of the 7,720 screened adolescents, 7,405 completely answered both the Patient Health Questionnaire – Adolescent Version (PHQ-A) and the Patient-Centered Assessment and Counseling for Exercise Plus Nutrition – Adolescent Physical Activity Measure (PACE+). Details of the data collection procedures can be found elsewhere.<sup>10</sup>

### Instruments

#### Sociodemographic variables

The participants answered questions about age, gender, race, and handedness. In conformity with Brazilian Institute of Geography and Statistics (IBGE) national census procedures race was categorized as White, Black, Asian, Mixed, or Indigenous.

#### Physical activity

We estimated physical activity levels using a modified version of the PACE+,<sup>12</sup> a two-item self-report questionnaire for screening of physical activity frequency and intensity. This questionnaire asks about the number of days on which respondents have been physically active for at least 60 minutes in the 7 preceding days and during a typical week. Total scores, which can range from 0 to 7, are the mean of the two questions. In addition to translating and adapting the instrument to Brazilian Portuguese following the Translation, Review, Adjudication, and Documentation method,<sup>13</sup> we also modified the instrument to avoid any difficulties adolescents might have with the concept of frequency: instead of responding how many days in a week, participants were asked to check boxes for each day of the week (Monday through Sunday or none) on which they engaged in moderate to vigorous physical activity.

#### Depressive symptoms

Depressive symptomatology was assessed using the Brazilian Portuguese version of the PHQ-A,<sup>14</sup> a self-administered instrument to assess depressive symptoms in adolescents. This nine-item scale determines the

frequency of DSM depression symptoms in the past week, including the response options not at all, several days, more than half the days, and nearly every day. Total scores range from 0 to 27, with higher scores indicating greater severity. The Translation, Review, Adjudication, and Documentation method<sup>13</sup> was used to modify the Brazilian Portuguese version of the PHQ-9 to incorporate the adaptations proposed for the adolescent population (PHQ-A).<sup>14</sup>

### Statistical analyses

We analyzed the distribution of PHQ-A scores according to PACE+ levels of physical activity, also stratifying analyses according to sex. Due to the non-normal distribution of both scores, we used Wilcoxon-Mann-Whitney *U* tests for median differences and a two-proportion *Z*-test to compare the proportion of physical activity between the sexes, with a significance level of 0.05. We performed listwise deletion on missing data for both the PACE+ and the PHQ-A results. We examined the intraclass correlation coefficient (ICC) by school for total PHQ-A and PACE+ scores to assess possible school-level influences in questionnaire responses. All statistical analyses were performed using R 3.6.1 and RStudio software).

### Ethics statement

The data were coded to ensure anonymity and stored in the REDcap platform at the Hospital de Clínicas de Porto Alegre. The study protocol was approved by the hospital's ethics committee (CAAE 50473015.9.0000.5327).

## Results

Of the 7,405 adolescents (96% of the original sample), 55% were female. The mean participant age was 15.7 years (standard deviation [SD] = 0.8), and 60.3% self-reported as White. There was negligible evidence of school clustering for both the PHQ-A (ICC = 0.009, 95% confidence interval [95%CI] 0.004-0.01) and the PACE+ (ICC = 0.012, 95%CI 0.006-0.021).

The median total score for PACE+ was 1.5 (IQR = 3.5), with boys reporting higher levels of physical activity in the last 7 days and in a usual week than girls ( $W = 9207149$ ,  $p < 0.001$ ) (Table 1). Only 3.8% of the overall sample met the WHO's recommendation of 60 minutes of moderate to intense exercise per day every day, while 84.4% did not reach 5 days per week, and 33.9% did not reach 1 day per week. The overall median PHQ-A score was 8 (IQR = 10), and girls had higher median PHQ-A scores than boys (11 [IQR = 10] and 6 [IQR = 7], respectively;  $W = 4057738$ ,  $p < 0.001$ ). Trouble falling asleep, staying asleep, or sleeping too much and feeling tired or having little energy were the most frequently reported symptoms (by approximately four in 10 adolescents) as occurring at least more than half the days.

Adolescents with a PACE+ score  $< 5$  had higher PHQ-A scores than those with a PACE+ score  $\geq 5$  (medians of 8 [IQR = 10] to 7 [IQR = 9],  $W = 4060461$ ,

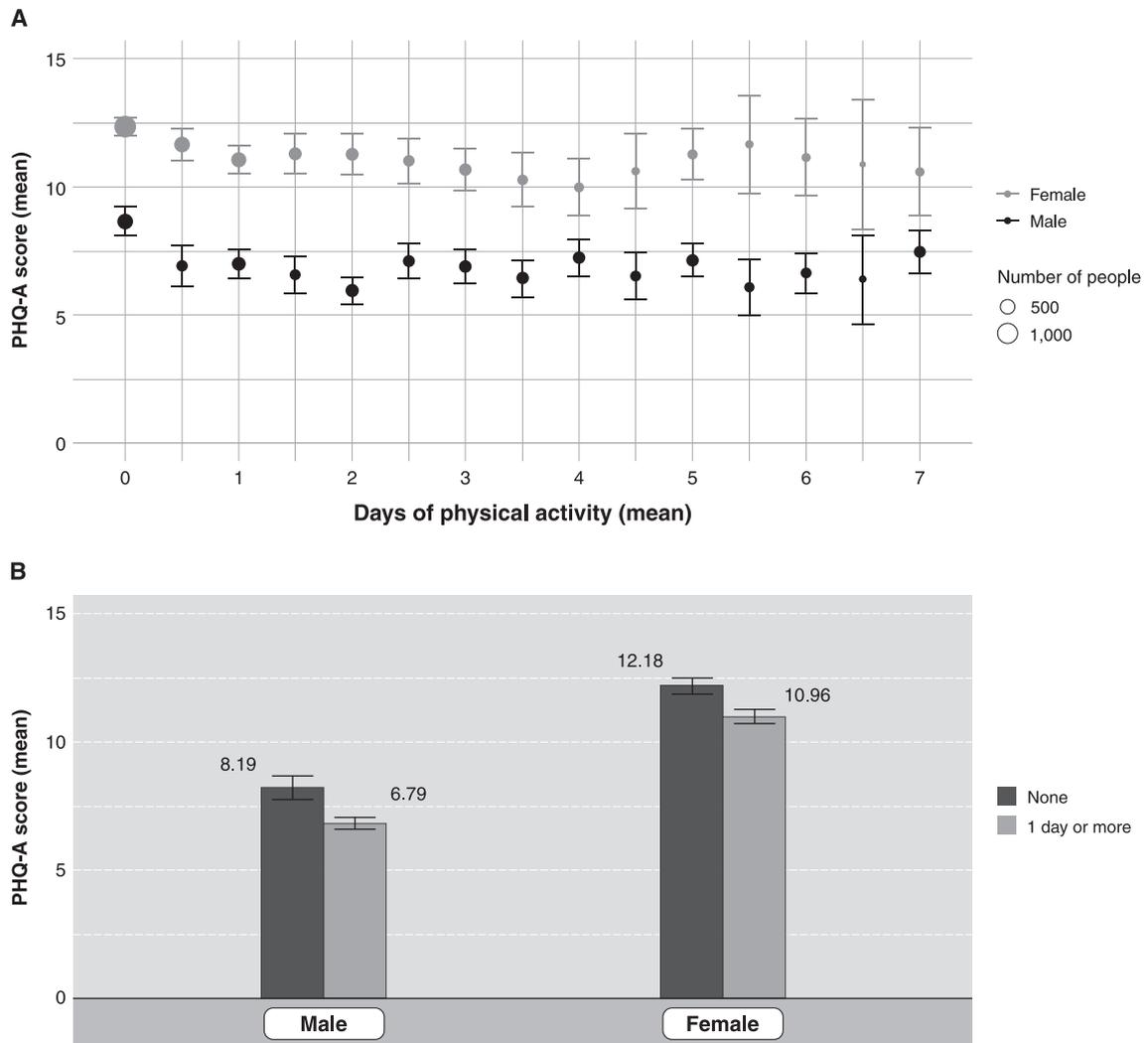
**Table 1** Physical activity and depressive symptoms by sex

| Measure     | All<br>(n=7,405) | Male<br>(n=3,328) | Female<br>(n=4,077) | Statistic   | p-value <sup>†</sup> |
|-------------|------------------|-------------------|---------------------|-------------|----------------------|
| PACE +      | 1.5 (0.0-3.5)    | 2.5 (1.0-4.5)     | 1.0 (0.0-2.5)       | W = 9207149 | < 0.001              |
| Past 7 days | 1.0 (0.0-4.0)    | 2.0 (1.0-5.0)     | 1.0 (0.0-2.0)       | W = 9098718 | < 0.001              |
| Usual week  | 2.0 (0.0-4.0)    | 3.0 (1.0-5.0)     | 1.0 (0.0-3.0)       | W = 9019434 | < 0.001              |
| PHQ-A       | 8.0 (4.0-14.0)   | 6.0 (3.0-10.0)    | 11.0 (6.0-16.0)     | W = 4057738 | < 0.001              |

Data presented as medians (1st quartile-3rd quartile).

PACE + = Patient-Centered Assessment and Counseling for Exercise Plus Nutrition – Adolescent Physical Activity Measure; PHQ-A = Patient Health Questionnaire – Adolescents.

<sup>†</sup> For comparison between males and females.



**Figure 1** Mean Patient Health Questionnaire – Adolescents (PHQ-A) score for males and females according to the frequency of physical activity. A) Mean PHQ-A score for females and males according to days of physical activity (0 to 7) and the distribution of adolescents who reported the number of days they exercise. B) Mean PHQ-A score for females and males who reported no physical activity and for those who reported exercising 1 or more days a week. The double-headed lines show the 95% confidence intervals.

$p < 0.001$ ). A similar pattern (Figure 1) was observed when using a cut-off of 1 (median of PHQ-A 10 [IQR = 11] for those with lower activity vs. 7 [IQR = 9] for those with higher activity,  $W = 7457608$ ,  $p < 0.001$ ).

The vast majority (80.1%) of the boys reported exercising at least 1 day a week. Boys who reported at least

1 day of exercise had lower PHQ-A scores (median = 5, IQR = 7) than those who reported not exercising (median = 7, IQR = 9,  $W = 997899$ ,  $p < 0.001$ ). Although a little more than the half of the girls (54.6%) reported exercising at least 1 day per week, the proportion of girls who reported no physical activity was much higher than boys

(45.4 vs. 19.9%,  $Z = 23.0413$ ,  $p < 0.001$ ). As with boys, girls who reported at least 1 day of exercise per week had lower PHQ-A scores than those who reported no exercise (medians of 10 [IQR = 9] vs. 12 [IQR = 10],  $W = 2275501$ ,  $p < 0.001$ ).

## Discussion

In a large school-based sample of adolescents from a middle-income country, we investigated the association between physical activity levels and depressive symptoms. We found that 84% of the participants did not meet the WHO recommendation for 60 minutes of moderate to vigorous physical activity each day. These results agree with Brazilian<sup>15</sup> (71% of elementary school students) and global<sup>6</sup> (81% of students aged 11-17 years) estimates of physical inactivity. The fact that approximately one-third of our sample reported less than one day of physical activity per week is a worrying finding of public health relevance.

Using two different cut-off points ( $\geq 5$  and  $\geq 1$ ), we found that participants with lower PACE+ scores reported higher PHQ-A scores, indicating that teenagers who do not exercise frequently may have more depressive symptoms – with pronounced scores for both variables among girls. Unfortunately, due to the cross-sectional nature of our data, no inferences about causality can be drawn from these results: it could be that a lower physical activity level leads to higher depression, that higher depression leads to a lower physical activity level, or even that both phenomena occur simultaneously. Interpretation of our findings is further hampered by the use of simple, self-reported measures to assess both physical activity and depressive symptomatology. However, both instruments have been shown to be valid in comparison to other more sophisticated measures,<sup>13,15</sup> which are not easily used in large samples. Nevertheless, the fact that the sample was recruited in a school setting limits the overall representativeness of the findings for the general population, especially youth who have dropped out of school.

Despite these limitations, identifying a group of adolescents with both low physical activity levels and high levels of depressive symptoms sheds light on a highly vulnerable group. We believe that early preventative efforts targeting both physical and mental health are urgently required to address this issue during this important developmental window of opportunity to change adverse health trajectories.

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## References

- 1 Patton GC, Sawyer SM, Santelli JS, Ross DA, Afifi R, Allen NB, et al. Our future: a Lancet commission on adolescent health and wellbeing. *Lancet*. 2016;11;387:2423-78.
- 2 World Health Organization (WHO). WHO guidelines on physical activity and sedentary behaviour. Geneva: WHO; 2020.
- 3 Dumith SC, Gigante DP, Domingues MR, Kohl HW 3rd. Physical activity change during adolescence: a systematic review and a pooled analysis. *Int J Epidemiol*. 2011;40:685-98.
- 4 Colley RC, Garriguet D, Janssen I, Wong SL, Saunders TJ, Carson V, et al. The association between accelerometer-measured patterns of sedentary time and health risk in children and youth: results from the Canadian Health Measures Survey. *BMC Public Health*. 2013;13:200.
- 5 Spittaels H, Van Cauwenberghe E, Verbestel V, De Meester F, Van Dyck D, Verloigne M, et al. Objectively measured sedentary time and physical activity time across the lifespan: a cross-sectional study in four age groups. *Int J Behav Nutr Phys Act*. 2012;9:149.
- 6 Guthold R, Stevens GA, Riley LM, Bull FC. Global trends in insufficient physical activity among adolescents: a pooled analysis of 298 population-based surveys with 1.6 million participants. *Lancet Child Adolesc Health*. 2020;4:23-35.
- 7 Paus T, Keshavan M, Giedd JN. Why do many psychiatric disorders emerge during adolescence? *Nat Rev Neurosci*. 2008;9:947-57.
- 8 Douglas J, Scott J. A systematic review of gender-specific rates of unipolar and bipolar disorders in community studies of pre-pubertal children. *Bipolar Disord*. 2014;16:5-15.
- 9 Avenevoli S, Swendsen J, He JP, Burstein M, Merikangas KR. Major depression in the national comorbidity survey-adolescent supplement: prevalence, correlates, and treatment. *J Am Acad Child Adolesc Psychiatry*. 2015;54:37-44.e2.

- 10 Kieling C, Buchweitz C, Caye A, Manfro P, Pereira R, Viduani A, et al. The Identifying Depression Early in Adolescence Risk Stratified Cohort (IDEA-RiSCo): rationale, methods, and baseline characteristics. *Front Psychiatry*. 2021;12:697144.
- 11 Kieling C, Adewuya A, Fisher HL, Karmacharya R, Kohrt BA, Swartz JR, et al. Identifying depression early in adolescence. *Lancet Child Adolesc Health*. 2019;3:211-3.
- 12 Prochaska JJ, Sallis JF, Long B. A physical activity screening measure for use with adolescents in primary care. *Arch Pediatr Adolesc Med*. 2001;155:554-9.
- 13 Harkness JA. Questionnaire translation. In: Harkness JA, van de Vijver FJ, Mohler PP, editors. *Cross-cultural survey methods*. Hoboken: John Wiley and Sons; 2003. p. 35-56.
- 14 Johnson JG, Harris ES, Spitzer RL, Williams JB. The patient health questionnaire for adolescents: validation of an instrument for the assessment of mental disorders among adolescent primary care patients. *J Adolesc Health*. 2002;30:196-204.
- 15 de Rezende LF, Lopes MR, Rey-López JP, Matsudo VK, Luiz Odo C. Sedentary behavior and health outcomes: an overview of systematic reviews. *PLoS One*. 2014;9:e105620.