

Physical Activity at 11 Years of Age and Incidence of Mental Health Problems in Adolescence: Prospective Study

Pedro C. Hallal, Jeovany Martínez-Mesa, Carolina V.N. Coll, Grégore I. Mielke, Márcio A. Mendes, Márcio B. Peixoto, Tiago N. Munhoz, Virgílio V. Ramires, Maria Cecilia Assunção, Helen Gonçalves, and Ana M. B. Menezes

Aim: To evaluate the longitudinal association between physical activity behavior at 11 years of age and the incidence of mental health problems from 11 to 15 years of age. **Methods:** Individuals born in the city of Pelotas, Brazil, in 1993 have been followed up since birth. At 11 and 15 years of age, mental health was assessed using the Strengths and Difficulties Questionnaire (SDQ). At 11 years of age, physical activity was assessed through a validated questionnaire. The continuous SDQ score at 15 years was used as the outcome variable. The main exposure was physical activity behavior at 11 years of age divided into 3 categories (0, 1–299, ≥ 300 min/wk). **Results:** The incidence of mental health problems from 11 to 15 years was 13.6% (95% CI, 12.4–14.9). At 11 years, 35.2% of the adolescents achieved 300 min/wk of physical activity. In the unadjusted analysis, physical activity was inversely related to mental health problems ($P = .04$). After adjustment for confounders, the association was no longer significant in the whole sample but was still significant among boys. **Conclusion:** Physical activity appears to be inversely related to mental health problems in adolescence, but the magnitude of the association is weak to moderate.

Keywords: adolescent, epidemiology, psychology

Mental health has been increasingly recognized as a major public health priority.¹ Mental health disorders affect people from all ages and socioeconomic positions.² Data from the World Health Organization suggest that around 20% of children and adolescents worldwide present mental health disorders,³ such as conduct problems, drug dependence, risk of suicide, depression, and anxiety. Mental health problems can significantly affect quality of life of children and adolescents and tend to persist into adulthood.⁴ A study on the burden of disease in Brazil showed that 19% of the disability adjusted life years related to chronic disease are due to mental health problems.¹ Another study in the South of the country showed that 26.8% of the adolescents present any type of mental health disorder.⁵

The possible influence of physical activity behavior on mental health has been studied over the past decades.^{6–8} A review reported an inverse association between physical activity and mental health disorders, albeit the magnitude of the effect was found to be weak to moderate and several studies were cross-sectional, thus impeding the analyses of temporality.⁸ Also, most studies on this topic were carried out in high-income countries where the nature of physical activity behavior might differ from that observed in low and middle-income countries, therefore leading to different health effects. Adolescence is a particularly relevant period of time for studies on this topic because several studies report a decline in physical activity levels throughout adolescence, particularly among girls.⁹

Our study evaluates the association between physical activity behavior at 11 years of age and the incidence of mental health problems from 11 to 15 years of age using data from a birth cohort study in Brazil.

Methods

All children born in the city of Pelotas, Brazil, in 1993 were eligible to be part of a birth cohort study; only 16 mothers refused to take part. The cohort included 5,249 participants. Subsamples of these children took part in several follow-up visits throughout infancy (1, 3, 6, and 12 months of age) and childhood (48 months of age). Further details about the methods employed are available elsewhere.^{10,11} At 11 and 15 years of age, for the first time, we attempted to follow up all cohort members after the visits to subsamples during infancy and childhood. We were able to successfully locate 87.5% and 85.7% of the adolescents at 11 and 15 years of age, respectively. In both visits, separate questionnaires were administered to the adolescents and their mothers (or guardians in the ~5% of the cases of absence of the mother). The maternal questionnaire investigated issues related to family composition, family income, and maternal and paternal job, as well as questions about maternal leisure-time physical activity. The questionnaire administered for the adolescent focused on behavioral and health variables.

Mental health was assessed in both visits using the Strengths and Difficulties Questionnaire (SDQ),^{12,13} which was filled by mothers (or guardians). The instrument comprises 25 questions divided into 5 subscales (Emotional Symptoms, Conduct Problems, Hyperactivity/Inattention, Peer Relationship Problems, Prosocial Behavior). A total score was later constructed as the sum of all subscales, ranging from 0 to 40 points. A cutoff point of 17 points in the score was used to define adolescents with mental health problems at the age of 11 years. The continuous score was used as the outcome variable in all analyses. The validity of the SDQ questionnaire administered to parents was tested in a sample of 403 children; SDQ presented correlations of 0.78 to 0.88 with the Rutter Scale, despite being considerably shorter.¹²

Physical activity at 11 years of age was assessed by self-report. A pretested and validated questionnaire was administered to the

The authors are with the Postgraduate Program in Epidemiology, Federal University of Pelotas, Brazil. Hallal (prchallal@gmail.com) is corresponding author.

adolescents.¹⁴ The questionnaire comprises questions on transportation mode to and from school and leisure-time physical activity. In this article, we analyze only leisure-time physical activity, because we have no information on whether the intensity of transport-related physical activity in our sample reaches the threshold for moderate intensity. A list of 15 leisure-time activities, including sports and other activities, was read to adolescents. This list was constructed after a pilot study in which we used open-ended questions on the activities more frequently practiced by adolescents. For each activity reported, adolescents were prompted to mention the weekly frequency and duration. A total weekly physical activity score was categorized into 3 groups (0 min/wk, 1–299 min/wk, ≥ 300 min/wk).

The reliability and concurrent validity of the physical activity questionnaire were tested in study we conducted some years ago.¹⁴ Its reliability was good ($\rho = 0.62$; $P < .001$); 73% of the subjects were classified consistently in a 7-days test–retest exercise. The kappa value was 0.58. The concurrent validity of the questionnaire was tested against pedometers; the Spearman correlation coefficient was 0.26 ($P = .02$), and 57% of the subjects did not reach the 300 min/wk threshold by the questionnaire and did not reach 10,000 steps per day by the pedometer.

To guarantee the longitudinal nature of the analyses, we excluded the 1333 participants who already had the outcome of interest (mental health problem, defined as 17 points or more in the SDQ score) at baseline (11 years of age). In addition, 7 individuals were excluded from all analysis due to missing data on mental health at 11 years of age. The analysis was therefore run with the 2,893 cohort members who were “disease-free” at baseline (11 years of age) and were followed up at 15 years of age. We conducted longitudinal analyses for boys and girls altogether and then stratified by gender. We compared the mean SDQ score at 15 years of age across physical activity categories at 11 years of age; significance was tested through linear regression models. Unadjusted and adjusted linear regression was performed.

Confounding variables included maternal mental health (assessed through the Self-Reporting Questionnaire: SRQ¹⁵), maternal leisure-time physical activity (based on maternal self-report and expressed in min/wk), maternal schooling (number of years of formal education), maternal smoking (self-reported by the mother), family socioeconomic position (standardized score created based on a list of assets in the household), father living in the household (reported by the mother), history of school failure (reported by the mother), adolescent skin color (reported by the adolescent), adolescent smoking (reported by the adolescent) and adolescent alcohol consumption (reported by the adolescent). Confounding variables were chosen based on the literature and on the possible association with both the outcome and exposure variables. Maternal schooling was the confounding variable with the highest number of missing cases ($N = 166$).

All phases of the 1993 cohort were approved by the Ethics Committee of the Federal University of Pelotas Medical School. Cohort members provided verbal consents and mothers (or guardians) provided written informed consent before data collection.

Results

Table 1 describes the sample; 35.2% of the adolescents achieved the 300-min/wk threshold in terms of physical activity behavior at 11 years of age; this proportion was higher among boys than girls ($P < .001$). The incidence of mental health problems was 13.6% (95%

CI, 12.4–14.9); it was significantly higher ($P = .006$) among girls (15.3%; 95% CI, 13.5–17.1) than boys (11.8%; 95% CI, 10.0–13.5).

Table 2 displays the means of the mental health score at 15 years according to categories of leisure-time physical activity at 11 years. The score was higher in the least active category in the whole sample, but not in the gender-stratified analysis.

In Table 3, we present the results of unadjusted and adjusted linear regression. In the unadjusted analyses, most coefficients were negative, suggesting an inverse association between physical activity and mental health problems ($P = .043$ for the whole sample). After stratification by gender and adjustment for confounders, this association was only significant for boys ($P = .044$).

Discussion

Our results suggest a possible effect of physical activity during adolescence at preventing mental health problems at 15 years of age. However, the magnitude of the effect is only modest, and the adjusted findings are only statistically significant among boys. Prospective studies on the effects of physical activity on mental health are much less abundant than studies on the impact of physical activity on chronic disease-related outcomes, and virtually nothing is available from low and middle-income countries. The causal mechanisms linking physical activity to better mental health are not fully understood,¹⁶ but both acute and long-term adaptations are suggested.¹⁶ Physical activity apparently influences the brain-derived neurotrophic factor, serotonin, and endorphins, and also relates to learning and social reinforcement.¹⁶ Most studies so far assessed the cross-sectional association between physical activity and mental health,⁸ which is subject to reverse causality, because physical activity is actually recommended in the treatment of some mental health disorders.⁷

We opted to exclude from the analyses the cohort members who already had the outcome of interest at baseline (11 years of age). By using this approach, we evaluated the influence of physical activity at baseline on the subsequent incidence of mental health problems. However, we were unable to study the determinants of mental health problems before the age of 11 years, because no follow-up visits of the full cohort are available at younger ages. Another limitation is the assessment of physical activity by self-report, which might dilute the magnitude of its association with health outcomes due to misclassification.¹⁷ This problem was minimized by using a questionnaire with evidence of reliability and validity.^{14,18} Another possible source of error is that physical activity is not stable, and cohort members might have changed their physical activity behavior after the 11 years follow-up visit; this could happen differently between boys and girls, for example. All these potential biases would tend to attenuate the association between physical activity and mental health, and therefore, the inverse associations are likely to be stronger than reported here. Finally, we have no data on father’s physical activity or education, 2 possible confounders.

There is much debate on the association between physical activity and mental health. The main reason is that mental health is a broad term that is connected to a series of different health problems. Available studies, mostly of cross-sectional nature, tend to report an inverse association between physical activity and mental health problems.^{19–25} However, some prospective studies are available on this topic. In Norway, a study with 3811 adolescents evaluated the effect of physical activity at 15 to 16 years of age on mental health at 18 to 19 years.²⁶ In the fully adjusted models, the authors found

Table 1 Description of the Sample: The 1993 Pelotas (Brazil) Birth Cohort Study

Categorical variables	Whole sample		Girls		Boys		P*
	n	% (95%CI)	n	% (95%CI)	n	% (95%CI)	
Adolescent sex							—
Boys	1354	46.8 (45.0–48.6)					
Girls	1539	53.2 (51.4–55.0)					
Adolescent leisure-time physical activity (11 years)							<.001
0 min/wk	531	18.9 (17.4–20.3)	369	24.7 (22.5–26.9)	162	12.3 (10.5–14.0)	
1–299 min/wk	1294	45.9 (44.1–47.8)	742	49.7 (47.1–52.2)	552	41.7 (39.1–44.4)	
≥300 min/wk	992	35.2 (33.4–37.0)	383	25.6 (23.4–27.9)	608	46.0 (43.3–48.7)	
Adolescent mental health (15 years)							.006
Normal	2493	86.4 (85.1–87.6)	1300	84.7 (82.9–86.5)	1193	88.2 (86.5–90.0)	
Deviant	393	13.6 (12.4–14.9)	234	15.3 (13.5–17.1)	159	11.8 (10.0–13.5)	
Adolescent skin color							.328
White	1965	70.2 (68.5–71.9)	1037	69.2 (66.9–71.6)	928	71.3 (68.9–73.8)	
Black	364	13.0 (11.8–14.3)	195	13.0 (11.3–14.7)	169	13.0 (11.2–14.8)	
Mixed	470	16.8 (15.4–18.2)	266	17.8 (15.8–19.7)	204	15.7 (13.7–17.7)	
Adolescent smoking (previous 30 days)							.002
Yes	128	4.5 (3.7–5.3)	85	5.6 (4.4–6.8)	43	3.2 (2.3–4.2)	
No	2720	95.5 (94.7–96.3)	1434	94.4 (93.2–95.6)	1286	96.8 (95.8–97.7)	
Maternal smoking							.360
Never smoker	1425	49.3 (47.5–51.1)	751	48.9 (46.4–51.4)	674	49.8 (47.1–52.4)	
Former smoker	657	22.7 (21.2–24.3)	365	23.7 (21.6–25.9)	292	21.6 (19.4–23.8)	
Current smoker	809	28.0 (26.3–29.6)	421	27.4 (25.2–29.6)	388	28.7 (26.2–31.1)	
Father living in the same house							.323
Yes	1764	61.1 (59.3–62.9)	925	60.3 (57.8–62.7)	839	62.1 (59.5–64.6)	
No	1123	38.9 (37.1–40.7)	610	39.7 (37.3–42.2)	513	37.9 (35.4–40.5)	
Alcohol experimentation							<.001
Yes	1651	58.3 (56.4–60.1)	936	61.6 (59.2–64.1)	715	54.4 (51.7–57.1)	
No	1183	41.7 (39.9–43.6)	583	38.4 (35.9–40.8)	600	45.6 (42.9–48.3)	
Continuous variables	Whole sample		Girls		Boys		P**
Variable	n	Mean (SD)	n	Mean (SD)	n	Mean (SD)	
SDQ score (15 years)	2886	9.66 (5.87)	1534	10.09 (5.99)	1352	9.19 (5.71)	<.001
Maternal SRQ (11 years)	2881	4.64 (4.00)	1535	4.66 (3.99)	1346	4.62 (4.01)	.816
Maternal schooling (highest grade)	2720	8.21 (4.19)	1451	8.18 (4.10)	1269	8.25 (4.28)	.649
School failure up to 15 years	2884	1.19 (1.31)	1536	0.92 (1.19)	1354	1.34 (1.39)	<.001

* Chi-square for heterogeneity; ** *t*-test.

Abbreviations: SDQ, Strengths and Difficulties Questionnaire; SRQ, Self-Reporting Questionnaire.

Table 2 Mental Health Score (Self-Reporting Questionnaire) at 15 Years of Age by Leisure-Time Physical Activity at 11 Years of Age (Unadjusted Analysis): The 1993 Pelotas (Brazil) Birth Cohort Study

Variable	Whole sample		Girls		Boys	
	n	Mean (SD)	n	Mean (SD)	n	Mean (SD)
Physical activity						
0 min/wk	530	10.31 (6.28)	368	10.48 (6.41)	162	9.92 (5.98)
1–299 min/wk	1290	9.53 (5.71)	740	9.97 (5.77)	550	8.93 (5.57)
≥300 min/wk	990	9.56 (5.85)	381	10.01 (6.06)	609	9.23 (5.70)

Table 3 Regression Models for the Association Between Physical Activity and Mental Health: The 1993 Pelotas (Brazil) Birth Cohort Study

	n	0 min/wk β (95%CI)	1–299 min/wk β (95%CI)	≥300 min/wk β (95%CI)	P*
Unadjusted					
Whole sample	2810	0.0	–0.779 (–1.372 to –0.185)	–0.744 (–1.363 to –0.125)	.043
Boys	1321	0.0	–0.985 (–1.982–0.011)	–0.688 (–1.674–0.297)	.507
Girls	1489	0.0	–0.508 (–1.259–0.243)	–0.386 (–1.247–0.475)	.366
Adjusted ^a					
Whole sample	2482	0.0	–0.393 (–0.980–0.194)	–0.519 (–1.143–0.105)	.123
Boys	1149	0.0	–1.146 (–2.142 to –0.151)	–1.237 (–2.218 to –0.255)	.044
Girls	1333	0.0	–0.066 (–0.803–0.671)	–0.117 (–0.960–0.725)	.785

* Wald test for linear trend; ^a Adjusted for maternal leisure-time physical activity when the cohort member was aged 11 years, maternal mental health when the cohort member was aged 11 years, maternal schooling and smoking when the cohort member was aged 15 years, family socioeconomic position when the cohort member was aged 15 years, adolescent's skin color, smoking and alcohol consumption, father living in the same house of the adolescent (yes vs. no) and sex (whole sample analysis only).

no association between physical activity and mental health. On the other hand, a study in the UK with adolescents aged 11 to 14 years found that achieving physical activity recommendations was related to lower likelihood of facing emotional problems afterward.²⁷ In our sample, such an effect was only observed among boys after adjustment for confounders.

Mental health must be interpreted as a multifactorial and complex process, influenced by biological, environmental, and social factors. Our study found an association between physical activity and mental health among boys, but not girls. The reasons why males and females take part in physical activity are different²⁸ and may help explain this finding. Boys are more likely to perform sports activities, mainly in groups, whereas girls are more likely to take part in individual activities.¹⁸ It is plausible to think that group activities will have a stronger positive influence of psychosocial behavior than will individual activities. Further studies are needed to help explain this finding.

Because physical activity is a positive behavior, exposing people to it is ethically acceptable. Therefore, we recommend experimental studies in this field to better understand the influence of physical activity on mental health.

Acknowledgments

The cohort study is supported by the Wellcome Trust. The initial phases of the cohort were funded by the European Union and the Brazilian National Program for Centers of Excellence (PRONEX), National Research Council (CNPq), and the Ministry of Health.

References

- Schmidt MI, Duncan BB, Azevedo e Silva G, et al. Chronic non-communicable diseases in Brazil: burden and current challenges. *Lancet*. 2011;377(9781):1949–1961. [PubMed doi:10.1016/S0140-6736\(11\)60135-9](#)
- Kessler RC, Angermeyer M, Anthony JC, et al. Lifetime prevalence and age-of-onset distributions of mental disorders in the World Health Organization's World Mental Health Survey Initiative. *World Psychiatry*. 2007;6(3):168–176. [PubMed](#)
- World Health Organization. *Caring for children and adolescents with mental disorders: setting WHO directions*. Geneva, Switzerland: World Health Organization; 2003.
- Dekker MC, Ferdinand RF, van Lang ND, Bongers IL, van der Ende J, Verhulst FC. Developmental trajectories of depressive symptoms from early childhood to late adolescence: gender differences and adult outcome. *J Child Psychol Psychiatry*. 2007;48(7):657–666. [PubMed doi:10.1111/j.1469-7610.2007.01742.x](#)
- Menezes AMB, Dumith SC, Martínez-Mesa J, et al. Problemas de saúde mental e tabagismo em adolescentes do sul do Brasil. *Rev Saude Publica*. 2011;45:700–705. [PubMed doi:10.1590/S0034-89102011000400009](#)
- Paluska SA, Schwenk TL. Physical activity and mental health: current concepts. *Sports Med*. 2000;29(3):167–180. [PubMed doi:10.2165/00007256-200029030-00003](#)
- Larun L, Nordheim LV, Ekland E, Hagen KB, Heian F. Exercise in prevention and treatment of anxiety and depression among children and young people. *Cochrane Database Syst Rev*. 2006;(3):CD004691. [PubMed](#)
- Biddle SJ, Asare M. Physical activity and mental health in children and adolescents: a review of reviews. *Br J Sports Med*. 2011;45(11):886–895. [PubMed doi:10.1136/bjsports-2011-090185](#)
- Malina RM. Physical fitness of children and adolescents in the United States: status and secular change. *Med Sport Sci*. 2007;50:67–90. [PubMed doi:10.1159/000101076](#)
- Victoria CG, Hallal PC, Araujo CL, Menezes AM, Wells JC, Barros FC. Cohort profile: the 1993 Pelotas (Brazil) Birth Cohort Study. *Int J Epidemiol*. 2008;37(4):704–709. [PubMed doi:10.1093/ije/dym177](#)
- Victoria CG, Araujo CL, Menezes AM, et al. Methodological aspects of the 1993 Pelotas (Brazil) Birth Cohort Study. *Rev Saude Publica*. 2006;40(1):39–46. [PubMed doi:10.1590/S0034-89102006000100008](#)
- Goodman R. The Strengths and Difficulties Questionnaire: a research note. *J Child Psychol Psychiatry*. 1997;38(5):581–586. [PubMed doi:10.1111/j.1469-7610.1997.tb01545.x](#)
- Fleitlich-Bilyk B, Goodman R. Prevalence of child and adolescent psychiatric disorders in Southeast Brazil. *J Am Acad Child Adolesc Psychiatry*. 2004;43(6):727–734. [PubMed doi:10.1097/01.chi.0000120021.14101.ca](#)

14. Bastos JP, Araujo CL, Hallal PC. Prevalence of insufficient physical activity and associated factors in Brazilian adolescents. *J Phys Act Health*. 2008;5(6):777–794. [PubMed](#)
15. Mari JJ, Williams P. A validity study of a psychiatric screening questionnaire (SRQ-20) in primary care in the city of Sao Paulo. *Br J Psychiatry*. 1986;148(1):23–26.
16. Zschucke E, Gaudlitz K, Strohle A. Exercise and physical activity in mental disorders: Clinical and experimental evidence. *J Prev Med Public Health*. 2013;46(Suppl 1):S12–S21.
17. Hallal PC, Dumith SC, Reichert FF, et al. Cross-sectional and longitudinal associations between physical activity and blood pressure in adolescence: Birth cohort study. *J Phys Act Health*. 2011;8(4):468–474.
18. Hallal PC, Bertoldi AD, Gonçalves H, Victora CG. Prevalência de sedentarismo e fatores associados em adolescentes de 10-12 anos de idade. *Cad Saude Publica*. 2006;22(6):1277–1287. [PubMed doi:10.1590/S0102-311X2006000600017](#)
19. Allison KR, Adlaf EM, Irving HM, et al. Relationship of vigorous physical activity to psychologic distress among adolescents. *J Adolesc Health*. 2005;37(2):164–166. [PubMed doi:10.1016/j.jado-health.2004.08.017](#)
20. Griffiths LJ, Dowda M, Dezaux C, Pate R. Associations between sport and screen-entertainment with mental health problems in 5-year-old children. *Int J Behav Nutr Phys Act*. 2010;7:30. [PubMed doi:10.1186/1479-5868-7-30](#)
21. Hamer M, Stamatakis E, Mishra G. Psychological distress, television viewing, and physical activity in children aged 4 to 12 years. *Pediatrics*. 2009;123(5):1263–1268. [PubMed doi:10.1542/peds.2008-1523](#)
22. Kirkcaldy BD, Shephard RJ, Siefen RG. The relationship between physical activity and self-image and problem behaviour among adolescents. *Soc Psychiatry Psychiatr Epidemiol*. 2002;37(11):544–550. [PubMed doi:10.1007/s00127-002-0554-7](#)
23. Parfitt G, Eston RG. The relationship between children's habitual activity level and psychological well-being. *Acta Paediatr*. 2005;94(12):1791–1797. [PubMed doi:10.1080/08035250500268266](#)
24. Steptoe A, Butler N. Sports participation and emotional well-being in adolescents. *Lancet*. 1996;347(9018):1789–1792. [PubMed doi:10.1016/S0140-6736\(96\)91616-5](#)
25. Ussher MH, Owen C, Cook D, Whincup P. The relationship between physical activity, sedentary behaviour and psychological well-being among adolescents. *Soc Psychiatry Psychiatr Epidemiol*. 2007;42(10):851–856. [PubMed doi:10.1007/s00127-007-0232-x](#)
26. Sagatun A, Sogaard A, Bjertness E, Selmer R, Heyerdahl S. The association between weekly hours of physical activity and mental health: A three-year follow-up study of 15-16-year-old students in the city of Oslo, Norway. *BMC Public Health*. 2007;7(1):155. [PubMed doi:10.1186/1471-2458-7-155](#)
27. Wiles NJ, Jones G, Haase A, Lawlor D, Macfarlane G, Lewis G. Physical activity and emotional problems amongst adolescents. *Soc Psychiatry Psychiatr Epidemiol*. 2008;43(10):765–772. [PubMed doi:10.1007/s00127-008-0362-9](#)
28. Azevedo MR, Araujo CL, Reichert FF, Siqueira FV, da Silva MC, Hallal PC. Gender differences in leisure-time physical activity. *Int J Public Health*. 2007;52(1):8–15. [PubMed doi:10.1007/s00038-006-5062-1](#)

Copyright of Journal of Physical Activity & Health is the property of Human Kinetics Publishers, Inc. and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.