

Original Article (short paper)

Association of organized physical activity and levels of cardiorespiratory fitness with indicators of mental health in children

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Abstract - Aim: To verify the associations between organized physical activity out of school (PA) and cardiorespiratory fitness (CRF) with indicators of mental health in children. **Methods:** This is a cross-sectional study, with a sample of 226 students (47% girls) of public school in the south of Brazil aged between 6 to 11 years-old (8.36 ± 1.46). The cardiorespiratory fitness was measured by running and walking-test in six minutes, following the procedures of the “Brazil Sports Project”. PA was evaluated through a question and the Strengths and Difficulties Questionnaire assessed mental health indicators. Generalized linear regressions were used with a confidence interval of 95%. **Results:** Total difficulties ($\beta = 2.691$; 95%CI, 0.181 to 5.200) and emotional symptoms ($\beta = 1.528$; 95%CI, 0.609 to 2.448) were inversely associated with PA. Total difficulties ($\beta = -0.013$; 95%CI, -0.022 to -0.003), hyperactivity/attention deficit ($\beta = -0.002$; 95%CI, -0.010 to -0.002), and peer relationship problems ($\beta = -0.002$; 95%CI, -0.003 to -0.001) were associated with CRF in boys. **Conclusion:** A total of difficulties and emotional problems presented an inverse association with PA. Further, CRF was inversely associated with total difficulties, hyperactivity-inattention, and peer relationship problems.

Keywords: mental health; physical activity; cardiorespiratory fitness; school children.

Introduction

In children, mental health condition is based on age-appropriate emotional and social-cognitive development once those factors indicate the ability of adaption to challenging events¹. On the other hand, mental disorders comprised a range of issues with distinct symptoms. Usually, they are characterized by an association of thoughts, emotions, behaviors, and relationships with others beyond the expected pattern². In the world, it is estimated that around 13% of the children present some mental disorder³. In Brazil, these indicators are similar, showing a prevalence ranging from 10 to 20%⁴. These disorders have been associated to genetic alterations, or to impacts resulting from environmental alterations such as extremely stressful situations, chronic adversities, loss of people that are close to the child, violence, besides sociocultural problems compromising the child development⁵. The persistence of these stressful events increased the risk in social and personal inter-relationships, academic difficulties and low self-esteem, which are closely related to characteristic symptoms of several mental disorders and behaviors⁶.

Recently, regular physical activity (PA) practice has been recognized as an alternative to attenuate the symptoms related to

mental and behavioral disorders⁷. Biddle, Asare⁸ suggested a small but positive effect of PA in young people's mental health indicators. Those studies showed that PA may lead to neurobiological, psychosocial and behavioral changes that most likely explain improvements in mood state and self-esteem⁹.

In addition, it is well known that high levels of cardiorespiratory fitness (CRF) also act as a factor of attenuation and protection regarding the mental health indicators symptomatology. Such evidence are observed in the adult populations¹⁰ while a reduced number of studies aimed to elucidate the relationships between the different contexts of PA practice and the CRF levels with mental health in children⁸ and fewer in the Brazilian population, which highlights the relevance of our study. In addition, the results could be useful for the development of health promotion public policies. Thus, this study aimed to identify the associations between the organized PA out of school and CRF with the different mental health indicators in children.

Methods

Study design

This study used a cross-sectional analysis of longitudinal data from a study aiming to evaluate the effects of a soccer intervention program on mental health, cognition, metabolic syndrome and inflammatory markers outcomes in children. Thus, for this study only baseline data were considered. The sample comprised of 232 students (114 girls) aged from six to 11 years old, from a public school in southern Brazil. All children from the first to fifth grade were invited to participate. The parents of the children who accepted to participate signed the consent form and the children, the term of assent. The study was approved by the Ethics and Research Committee with human beings of *the Federal University of Rio Grande do Sul* (2.611.180).

The minimum number of subjects was calculated through the software G*Power version 3.1. For the sample size calculation, a weak effect size ($f^2 = 0.13$), a statistical power of 0.80, and alpha equal to 0.05 were adopted. Considering mental health indicators as dependent variables, in which the generalized linear regression models by sex were used, with four predictors, and an increase of approximately 5% to cover possible losses and refusals, a total of 110 children of each gender was recruited.

Instruments and collection procedures

Assessments were carried-out between March and May 2017. Initially, the researcher went to the school to explain the study objectives to the school managers, who signed an agreement form. Then, data collections were scheduled. CRF evaluation, body mass, and height measurements were performed in the school by a team of trained researchers during physical education classes. For data collection regarding mental health, organized PA out of school and socioeconomic level, the parents attended a meeting in which they answered a questionnaire. For those who could not attend, an individual meeting at the school was scheduled via telephone.

Cardiorespiratory fitness

In order to assess cardiorespiratory fitness, children performed the running and walking-test in 6 minutes. This test was used in Brazilian children and adolescents as a predictor of oxygen uptake peak¹¹ and is internationally validated¹². The students were divided by small groups appropriate to the dimensions of the sports court (usually 10). The importance of maintaining a constant running pace was emphasized, avoiding walks and sprints. Students were oriented to run as long as possible. During the test, the passage of time of 3' and 5' was informed. Through a sign, at the end of the test, the students interrupted the test remaining in the place where they were, so the distance performed during the 6 minutes (in meters) could be recorded.

Organized physical activity out of school

Organized PA out of school was characterized as a structured PA practiced with some purpose out of school hours or during leisure time. It was included in the present study because

the students from the first to the fifth year of public schools do not have physical education classes in their curriculum. It was also conducted in order to identify if the children are engaged in any physical activity or sports practice during leisure time.

PA out of school was assessed through an anamnesis directed to the parents, assessed PA out of school. The questionnaire had several questions about their children, including: "Is your son engaged in any organized physical activity out of school, such as soccer, gymnastics or volleyball classes, among others?" The answers options were "yes" and "no".

Anthropometric evaluation

Height was assessed in centimeters with one decimal scale through a tape fixed on the wall and extended from the bottom up, with the children maintained upright, with their feet and trunk against the wall. Body mass was measured through an anthropometric scale, with a precision of 500 grams and recorded in kilograms with the use of one decimal scale. The children should be barefoot, wearing light clothes, standing with their arms close to their bodies. Both assessments followed the PROESP-Br¹³ procedures. Thus, body mass index (BMI) was calculated, determined by dividing body mass (kg) by height (m) squared.

Socioeconomic level

It was assessed by an adaption of the questionnaire of the Brazilian Association of Research Companies (2015)¹⁴ considering the head of a household's education level and the number of certain items they have, and then they received a score according to the response. The sum of these scores allowed to know the social class in which the family is allocated: A1, A2, B1, B2, C1, C2, D or E. Then, the social classes were categorized as high (A1+A2), middle (B1+B2+C1+C2) and low (D+E).

Mental health

Mental Health was evaluated through the "Strengths and Difficulties Questionnaire" (SDQ)¹⁵, which consists of a behavioral screening of children. It presents three versions that could be answered by children, teachers, and, in this case, by the children's parents/guardians. SDQ approaches behavioral questions in children between 03 and 12 years old. It contains 25 items, which are organized into five domains: emotional symptoms, conduct problems, hyperactivity-inattention; peer relationship problems; and pro-social behavior. The responsible person should take into account the last six months of the children to mark "True", "More or less true" and "False".

For the final analysis, the scores were generated for the domains used in this study (emotional symptoms, conduct problems, hyperactivity-inattention; peer relationship problems), through the sum of these four indicators (total difficulties). Pro-social behavior was not included in the study as it is positive conduct. For all the above-mentioned domains, we used the cut-off points suggested by SDQ splitting the indicators as healthy and risk for health. Thus, a sum of the five questions in each domain was performed, and, for the total of difficulties, the sum of the four domains was performed. The score established

by the questionnaire is: healthy (total difficulties: 0-16; emotional symptoms: 0-4; conduct problems: 0-3; hyperactivity-inattention: 0-6 peer relationship problems: 0-3) and risk (total of difficulties: above 17; emotional symptoms: above 5; conduct problems: above 4, hyperactivity-inattention: above 7; peer relationship problems: above 4).

Statistical analysis

Descriptive data are shown as mean, standard deviation and frequency. All variables were tested for normality through the Shapiro-Wilk test. The variable that did not present a normal curve (conduct problems and peer relationship problems) were transformed into a square root. Differences between genders were analyzed through the independent *t* test and the Pearson chi-square test.

In addition, the internal consistency of the SDQ scales was calculated using Cronbach's Alfa, indicating 0.80 (total of difficulty) as acceptable reliability. The results obtained for each domain were, respectively: 0.55 for emotional symptoms; 0.62 for conduct problems; 0.72 for hyperactivity-inattention; and 0.47 for peer relationship problems.

Generalized linear regression analyses to verify associations between variables of interest were used. For all analyses it was used the software IBM SPSS version 20.0, considering alfa of 5%. The dependent variables of the present study were mental health indicators (total of difficulties, emotional symptoms, conduct problems, hyperactivity-inattention, and peer relationship problems) and the independent variables consisted of the organized PA out of school and CRF, stratified by sex. All analyses were adjusted by socio-economic level and age. The adjustment

variables of the model were defined based on the existing literature. In addition, multicollinearity values were tested.

Results

Table 1 presents the characteristics of the sample. A difference between CRF means was found with boys having better performance than girls ($t = 3.39$; $p = 0.001$; d Cohen = 0.39).

Table 2 presents the associations between organized PA out of school and CRF with mental health indicators, adjusted for socioeconomic level and age. Boys who practice organized PA out of school score lower in total difficulties by 2,691 points and in emotional symptoms by 1,528 points compared to those who do not practice PA out of school. Regarding CRF indicators, an inverse association was also observed with the total of difficulties (-0.013), hyperactivity-inattention (-0.006) and peer relationship problems (-0.002) in boys.

Discussion

Our results indicated an elevated number of children with the risk of developing different mental health indicators. Moreover, inverse associations were found between CRF levels and organized PA practice out of school with mental health indicators in boys.

Literature presents distinct values regarding the risk of mental health indicators in children. A similar study conducted with Brazilian children showed equivalent values to ours¹⁶. On the other hand, international studies presented lower prevalences^{3,17}. These differences can be explained by each country par-

Table 1 - Descriptive characteristics of sample, separated by sex.

Characteristics of sample	Boys (n = 118)		Girls (n = 114)	
	N	Mean (SD)	N	Mean (SD)
Total difficulties (points)	118	11.58 (6.61)	108	11.29 (5.69)
Emotional symptoms (points)	118	3.47 (2.32)	108	3.19 (2.10)
Hyperactivity-inattention (points)	118	4.19 (2.72)	108	4.20 (2.39)
Conduct problems (points)	118	1.16 (0.80)	108	1.23 (0.78)
Peer relationship problems (points)	118	1.11 (0.83)	108	1.12 (0.71)
CRF (m)	102	791.37 (138.07) ^a	100	749.75 (109.46)
BMI (kg/m ²)	112	17.93 (3.51)	108	17.96 (4.10)
Age (years)	118	8.42 (1.45)	107	8.44 (1.53)
	N	%	N	%
PA				
Yes	57	49.6	41	39.0
No	58	50.4	64	61.0
SES				
Middle	37	32.5	32	31.4
Low	77	67.5	70	68.6

CRF: Cardiorespiratory fitness; BMI: Body mass index; PA: physical activity; SES: socioeconomic status; N: number of subjects; SD: standard deviation; ^astatistically significant difference between boys and girls $p < 0,05$ for independent T test.

Table 2 - Association of organized PA out of school and CRF with indicators of mental health.

	Boys (n = 96)			Girls (n = 93)		
	β	95%CI	p	β	95%CI	p
Total difficulties						
PA						
No ^a						
Yes	-2.691	(-5.200 to -0.181)	0.03*	-1.845	(-4.040 to 0.350)	0.09
CRF	-0.013	(-0.022 to -0.003)	< 0.01*	-0.005	(-0.015 1.045)	0.30
Emotional symptoms						
PA						
No ^a						
Yes	-1.528	(-2.448 to -0.609)	< 0.001*	-0.714	(-1.563 to 0.135)	0.09
CRF	-0.001	(-0.005 0.002)	0.56	-0.001	(-0.005 0.003)	0.52
Hyperactivity-inattention						
PA						
No ^a						
Yes	-0.425	(-1.500 to 0.649)	0.43	-0.771	(-1.749 to 0.208)	0.12
CRF	-0.006	(-0.010 -0.002)	< 0.001*	-0.001	(-0.005 0.004)	0.73
Conduct problems						
PA						
No ^a	1					
Yes	-0.242	(-0.554 to 0.070)	0.12	-0.010	(-0.321 to 0.302)	0.95
CRF	0.000	(-0.001 0.001)	0.84	0.000	(-0.002 0.001)	0.53
Peer relationship problems						
PA						
No ^a	1					
Yes	-0.154	(-0.470 to 0.163)	0.34	-0.253	(-0.529 to 0.023)	0.07
CRF	-0.002	(-0.003 -0.001)	< 0.001*	0.000	(-0.002 0.001)	0.46

^areference category; PA: organized PA out school CRF: cardiorespiratory fitness; 95%CI: 95% confidence interval lower and upper. All analyzes were adjusted for socioeconomic level and age. *p < 0,05.

ticularities, as economic and educational development levels as well as social issues that could compromise the estimated prevalence, when considering different places of the world.

In addition, the present study aimed to analyze the associations between different PA indicators with some mental health disorders already evidenced in children¹⁸⁻²⁰. Among the different factors associated with mental health, the literature suggests the importance of regular PA practice, due to its social and behavioral roles, but also the relevance of neurobiological effects from exercise by means of changes in structural and functional compositions of the brain, which may be associated to the prevention and attenuation of mental disorders²¹.

Given that, the results of our study might provide an additional contribution to better understanding of the relationships between PA practice and the different mental health indicators in children. Indeed, our findings showed that the total of difficulties was associated with both PA regular practice out of school

and CRF levels in boys. Such results are in accordance with the study of Khan, Hillman²² indicating that adolescents who did not reach daily PA recommendations (< 60 min/day), presented greater scores of difficulties. In the same population, Sagatun, Sogaard, Bjertness, Selmer, Heyerdahl¹⁹ showed that those who practiced between 5 and 7 hours of PA per week were those who presented the lowest scores of total numbers of difficulties. Although limited, the studies investigating these relationships, reported similar results between 4 and 12 years old.²⁰ It should be noted that such findings are more consistent in boys than girls. This may be associated with the increasingly significant reduction of girls involved in regular PA practices²³.

Regarding the association between organized PA practice out of school and emotional symptoms, Ortlieb et al.¹⁸ found similar results and suggested that PA practice, independent of CRF levels, is associated with emotional symptoms indicators. However, this study carried-out with German girls who were

followed over 10 years, and the opportunity of involvement in moderate PA was associated with lower scores of emotional symptoms. Moreover, a previous study conducted with boys using the same instrument of the present study showed that the number of hours spent in PA per week was inversely associated with emotional symptoms¹⁹. Therefore, the socialization with friends or colleagues that the PA promotes may contribute to the improvement of anxiety and depression symptoms, as contact with other children assists in mental well-being.

Another important aspect to be considered is that moderate/vigorous PA can contribute to the improvement of CRF, which is an important general health indicator of children²⁴. Recent evidence showed that increased CRF levels are associated with improved mental health in adults⁹. Besides assisting in the improvement of mental health, elevated levels of CRF act as protectors of possible future depressive events, given that CRF is physiologically associated with the functional connectivity of the brain¹⁰. Thus, the present study adds new evidence on this topic in the child population. The results found show that the total of difficulties, hyperactivity-inattention, and peer relationship problems are negatively associated with CRF levels in boys. However, we did not find data in the literature corroborating the findings regarding the total of difficulties and hyperactivity-inattention.

Regarding peer relationship problems, Smith, Ullrich-French, Ii, Hurley²⁵ showed that children with a better relationship with their peers felt more motivation to practice sports and, consequently, present better CRF levels. Despite the scarcity of studies in this topic, a hypothesis that could explain the relationship between mental health and CRF levels lies in the understanding that CRF would be directly associated with the inhibitory control, once better CRF levels are able to activate frontal and parietal circuits in more demanding cognitive tasks²⁶. Thus, regular PA practice may promote better CRF levels and, consequently, can be related to changes in mental health indicators. For that, there are possible functional and physiological explanations. The first hypothesis explains that PA promotes improvements in attention and information processing. The second indicates the benefits of PA in increasing cerebral blood flow, neuroplasticity, neurotransmitter levels as serotonin and noradrenaline and the production of neurophins as the brain-derived neurotrophic factor²⁷. Moreover, PA and sports practice, independent of the improvement in physical fitness levels, promote the involvement in social relationships, which can also improve mental health.

This study brings new information regarding the relationship between mental health and PA, approaching different behavioral and emotional indicators. In addition, to the best of our knowledge, this is one of the first studies considering the association between CRF levels and mental health in Brazilian children. We emphasize the relevance of investigating this topic, considering that mental health problems have been appearing earlier and more frequently in life. Thus, regular PA practice could be considered a condition and behavior related to the prevention and treatment of these different disorders.

Despite the relevance of these findings, some limitations must be considered. This study has a cross-sectional design,

which does not allow determining the cause-effect relationship. In addition, mental health and PA were indirectly measured. We also understand the risk of bias when parents report about PA and mental health of their children since once they do not spend all the time together. Even so, we consider that parents are the most suitable to answer about competence, behavior problems and the PA of their children. The sample was not representative, which does not allow extrapolating the data for the entire population. However, SDQ is a valid and adequate instrument for this type of research²⁸. Besides, this study is one of the pioneers in children, it can be used as a basis for future epidemiological researches. In order to advance in this area, population and intervention studies are required in this context, as well as to consider the type, intensity and time spent in PA.

In conclusion, organized PA out of school and CRF levels are inversely associated with mental health indicators in boys. A total of difficulties and emotional problems presented an inverse association with PA. Moreover, CRF was inversely associated with total difficulties, hyperactivity-inattention, and peer relationship problems.

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