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Association between health-related physical fitness and academic performance in adolescents

Associação entre a aptidão física relacionada à saúde e o desempenho acadêmico em adolescentes

Fábio Jorge Santos de Castro[1]
Antonio Cesar Cabral de Oliveira[2]

Abstract – This study aimed to verify the association between health-related physical fitness and academic performance in adolescents. Overall, 326 students aged 15-18 years of the Federal Institute of Sergipe (IFS) participated in this cross-sectional study. Data relating to physical fitness were collected by applying the following tests: body mass index, sit and reach, abdominal in one minute and one mile running, which comprise the American Alliance for Health, Physical Education, Recreation and Dance testing battery. Academic performance was measured by the grades of two-month period in the disciplines that comprise the following areas of knowledge: languages and codes, natural sciences and humanities, obtained from the IFS school record. Students with average grades ≥ 6.0 were considered on satisfactory academic performance. The prevalence of physical unfitness in the sample was 15.8% (girls 15.4%; boys 16.4%) in body composition, 32.3% (girls 23.1%; boys 41.5%) in flexibility, 93.0% (95.8% girls; 90.2% boys) in muscular strength and 86.9% (85.3% girls; 88.5% boys) in cardiorespiratory endurance. On academic performance, the prevalence of adolescents below the average grade was 8.8% (girls 5.6%; boys 12.0%) in languages and codes, 24.5% (girls 19.5%; boys 29.5%) in natural sciences and 12.8% (girls 11.9%; boys 13.7%) in humanities. Adolescents with low cardiorespiratory endurance levels were more likely to have worse academic performance (OR=2.39; CI95%=1.05 to 5.44). It was concluded that low cardiorespiratory endurance levels were associated with worse academic performance.

Key words: Adolescents; Physical fitness; Academic performance.

Resumo – *Este estudo objetivou verificar a associação entre os componentes da aptidão física relacionada à saúde e o desempenho acadêmico em adolescentes. Participaram desse estudo transversal 326 estudantes de 15 a 18 anos do Instituto Federal de Sergipe (IFS). Os dados relativos à aptidão física foram coletados mediante aplicação dos seguintes testes: índice de massa corporal, sentar e alcançar, abdominal em 1 minuto e corrida de uma milha, que compõem a bateria de testes da American Aliance for Health, Physical Education, Recreation and Dance. O desempenho acadêmico foi medido pelas notas do bimestre nas disciplinas que compõem as áreas de conhecimento: linguagens e códigos, ciências da natureza e ciências humanas, obtidas junto ao registro escolar do IFS. Estudantes com médias ≥ 6,0 foram considerados com desempenho acadêmico satisfatório. A prevalência de inaptidão física na amostra foi de 15,8% (moças 15,4%; rapazes 16,4%) na composição corporal, 32,3% (moças 23,1%; rapazes 41,5%) na flexibilidade, 93,0% (moças 95,8%; rapazes 90,2%) na força/resistência muscular e 86,9% (moças 85,3%; rapazes 88,5%) na resistência cardiorrespiratória. Sobre o desempenho acadêmico, a prevalência de adolescentes abaixo da média foi de 8,8% (moças 5,6%; rapazes 12,0%) nas linguagens e códigos, 24,5% (moças 19,5%; rapazes 29,5%) nas ciências da natureza e 12,8% (moças 11,9%; rapazes 13,7%) nas ciências humanas. Adolescentes com baixos níveis de resistência cardiorrespiratória apresentaram mais chances de terem pior desempenho acadêmico (OR=2,39; IC95%=1,05-5,44). Conclui-se que baixo nível de resistência cardiorrespiratória se associou com pior desempenho acadêmico.*

Palavras-chave: *Adolescentes; Aptidão física; Desempenho acadêmico.*

1 Federal Institute of Sergipe. Aracaju, SE. Brazil.

2 Federal University of Sergipe. Graduate Program in Physical Education. São Cristóvão, SE. Brazil.

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INTRODUCTION

The maintenance of satisfactory health-related physical fitness levels, especially of its four components (body composition, flexibility, muscular strength and cardiorespiratory endurance) has been recommended for individuals of both sexes in different age groups[1]. However, more emphasis has been given for children and adolescents, since in these stages of life the body seems to be more sensitive to changes related to motor aspects and body composition[2].

Physical fitness has been associated with a variety of health benefits. Being physically fit reduces the risk of cardiovascular diseases, type II diabetes and obesity[3] and improves psychological variables such as depression, anxiety and stress[4].

The impact of high physical fitness levels on the health of children and adolescents is also associated with improved brain and cognitive function and academic performance[5], constituting a current concern with the development process of the human being in a global context.

The main studies on this topic have been conducted in the United States[4,6-8] and in some countries of Europe[9-12]. Developing countries still pay little attention to the subject, given the limited number of studies available in literature. In Brazil, for example, despite the different methods, only two studies related to the topic have been found. One was carried out in São Paulo[13] in 1996, in which the authors compared the Intelligence Quotient (IQ) of obese and eutrophic Brazilian children and adolescents. The results showed better performance of the eutrophic group in the intelligence test, revealing greater speed and dexterity in resolving problems, and the other in the state of Pernambuco[14] in 2012, which found a positive association between cardiorespiratory fitness and academic performance in adolescents, showing that the higher the oxygen volume consumed during a physical test, the better the performance in mathematics.

Given the above, it is of paramount importance conducting studies on the subject, particularly dealing with the relationship between health-related physical fitness components and academic performance in different social contexts, populations and education levels for a better understanding of the subject.

Thus, the aim of this study was to investigate the association between the four components (body composition, flexibility, muscular strength and cardiorespiratory endurance) of health-related physical fitness (HRPF) and academic performance of high school students, as measured by all the disciplines that make up the high school curriculum in Brazil.

METHODOLOGICAL PROCEDURES

Ethical aspects

This cross-sectional study was carried out at the Federal Institute of Sergipe - Campus of Aracaju, after authorization from the general direction and

approval from the Ethics Research Committee of the Federal University of Sergipe (Protocol No. 1.056.716). Participants and their parents signed the informed consent form.

Population and sample

The population consisted of 627 adolescents of both sexes aged 15-18 years enrolled in technical high-school courses of the Federal Institute of Sergipe - Campus of Aracaju in the period of data collection (May / June 2015). The sample size was calculated using the equation proposed by Luiz and Magnanini[15] for epidemiological investigations. It was considered 60% (average value found in the literature) as expected proportion of the prevalence of low physical fitness in adolescents, with confidence level of 1.96 and margin of error of 5% in the estimated prevalence, with 20% increment for possible losses. Thus, a sample size of 280 students was estimated.

To achieve the required amount, the sample was proportionally stratified into groups according to sex and age, according to the following inclusion criteria: being a high-school student with school attendance ≥ 75%; having from 15 to 18 years of age; having physical conditions to perform the tests. Exclusion criteria were: transitory limitation that prevented the performance of physical tests and being absent on the day of data collection. Given that all high-school students were invited to participate in the study, the final "n" was 326 adolescents.

Instruments and procedures for data collection

Data were collected for the following variables: height, body mass, body composition, flexibility, muscular strength, cardiorespiratory endurance and academic performance.

Height was measured using a Sanny® stadiometer (São Paulo, Brazil) model Professional, with measuring range of 40-220 cm and scale in mm and body mass using a Filizola® electronic scale (São Paulo, Brazil) Model Beyond Technology, with maximum load of 200 kg and minimum load of 1 kg with fractions of 50 g. These measures followed international guidelines[16]. Body composition was evaluated by body mass index (BMI), following guidelines and reference criteria of the American Alliance for Health, Physical Education, Recreation and Dance – AAHPERD[17].

Flexibility was measured by the sit and reach test using Wells' bench and mat. Muscular strength was measured by the 1-minute abdominal test using mat and stopwatch. Cardiorespiratory endurance was estimated by the test of running and / or walking 1 mile (1.609m) using running track and stopwatch. All tests followed the protocol and were classified according to the reference criteria of AAHPERD[17] shown in Table 1.

In order to control quality and ensure greater accuracy in the data collection process, all raters (Physical Education teachers and trainees) have been trained to follow the testing protocols and each acted solely on the application of one of the tests.

Box 1. Reference criteria of health-related physical fitness of AAHPERD

AGE	Health-related physical fitness components							
	Body Mass Index (kg/m2)		Flexibility (cm)		Muscular strength (rep./1 min)		Cardiorespiratory endurance (min and s)	
	M	F	M	F	M	F	M	F
15	17-24	17-24	25	25	42	35	7:30	10:30
16	18-24	17-24	25	25	44	35	7:30	10:30
17	18-25	17-25	25	25	44	35	7:30	10:30
18	18-26	18-26	25	25	44	35	7:30	10:30

M = Male and F = Female

Academic performance was measured by the average grades of disciplines that make up the areas of Languages and Codes (Portuguese Language, English Language, Physical Education, Arts and Information), Natural Sciences (Mathematics, Physics, Chemistry and Biology) and Humanities (Sociology, Philosophy, History and Geography) obtained from the two-month school period in which the collection was performed. These grades were provided by the School Registration Coordination of the institution. For each area of knowledge, average grade equal to or greater than 6.0 was considered satisfactory academic performance, as it is the cutoff point used by the school to consider the student approved. For the general academic performance, average grade equal to or greater than 6.0 on the sum of the areas of knowledge was considered satisfactory.

Statistical treatment

For the organization and tabulation of data, the Microsoft Office Excel for Windows® software (Washington, United States) version 8.1 was used and for statistical analysis, the BioEstat® software (Amazonas, Brazil) version 5.3 was used.

The descriptive statistical technique was used to define the sample profile (mean and standard deviation for continuous variables and median and range for discrete variables) and determine the prevalence of adolescents eligible and / or unfit in relation to physical fitness and academic performance (relative frequency and 95% confidence interval) according to gender. The chi-square test was the option adopted to compare groups. To determine the association between physical fitness and academic performance, binary logistic regression test was applied, which has the odds ratio as association measure. All variables were adjusted for sex and age. Significance level of 5% ($p < 0.05$) was adopted.

RESULTS

The sample consisted of 326 adolescents and characteristics of variables analyzed in the study are presented in Table 1.

Table 2 shows the prevalence of unfit subjects in relation to HRPF components considering the reference criteria of AAHPERD and academic performance considering the areas of knowledge. Table 2 shows high percentages of physical unfitness in both sexes. Analyzing the results of groups, it appears that the female group showed lower prevalence of

unfitness in flexibility and the male group in muscular strength ($p < 0.05$). However, in relation to body composition and cardiorespiratory endurance, there was no significant difference between sexes ($p > 0.05$).

Table 3 shows the association between HRPF components and academic performance of adolescents. Only the cardiorespiratory endurance component was associated (adjusted analysis) with academic performance, and being unfit in that component increased by twice the likelihood of poor academic performance.

Table 1. Description of the sample characteristics.

VARIABLES	Female (n=143)				Male (n=183)			
	$\bar{X}$	Md	SD	A	$\bar{X}$	Md	SD	A
Age (years)	17.1	17.1	0.9	3.6	17.1	17.2	1.0	3.9
Body mass (kg)	56.2	54.1	11.7	67.8	66.5	64.3	14.1	70.1
Height (m)	1.63	1.62	0.06	0.38	1.75	1.74	0.07	0.44
Body composition / MBI (kg/m^2)	21.2	20.6	3.8	23.1	21.7	21.2	4.2	25.6
Flexibility (cm)	30	30	8	53	26	27	9	47
Muscular strength (rep./1 min)	22	22	8	47	31	31	9	49
Cardiorespiratory endurance (min and s)	12:27	12:24	1:43	9:32	9:48	9:20	2:06	9:00
General academic performance (grades)	7.3	7.5	1.1	6.1	7.0	7.4	1.3	6.9

Notes: rep./1 min = replicates per 1 min; grades = average grade on a scale from 0 to 10 of disciplines that make up the three areas; $\bar{X}$ = average; Md = median; SD = standard deviation; A = amplitude.

Table 2. Prevalence of unfit adolescents in relation to health-related physical fitness components and academic performance below average.

Variables	Total sample		Female		Male	
	%	(CI 95%)	%	(CI 95%)	%	(CI 95%)
HRPF components						
Body composition	15.8	(11.8-19.8)	15.4	(9.5-21.3)	16.4	(11.0-21.8)
Flexibility	32.3	(27.2-37.4)	23.1	(16.2-30.0)	41.5*	(34.4-48.6)
Muscular strength	93.0	(90.2-95.8)	95.8*	(92.5-99.1)	90.2	(85.9-94.5)
Cardiorespiratory endurance	86.9	(83.2-90.6)	85.3	(79.5-91.1)	88.5	(83.9-93.1)
Areas of knowledge						
Languages and codes	8.8**	(5.7-11.9)	5.6	(1.8-9.4)	12.0*	(7.3-16.7)
Natural sciences	24.5**	(19.8-29.2)	19.5	(13.0-26.0)	29.5*	(22.9-36.1)
Humanities	12.8**	(9.2-16.4)	11.9	(6.6-17.2)	13.7	(8.7-18.7)

Note: HRPF = Health-Related Physical Fitness; CI 95% = 95% confidence interval; * Significant difference between sexes ($p < 0.05$); ** Significant difference among areas of knowledge (p 0.001).

Table 3. Association between health-related physical fitness components and academic performance.

VARIABLES	Crude or (CI 95%)	p-value	Adjusted OR [1] (CI 95%)	p-value
Body composition				
Fit	1	0.562	1	0.593
Unfit	1.31 (0.53-3.27)		1.30 (0.51-3.29)	
Flexibility				
Fit	1	0.122	1	0.217
Unfit	0.61 (0.32-1.14)		1.52 (0.78-2.94)	
Muscular strength				
Fit	1	0.034	1	0.068
Unfit	2.78 (1.08-7.13)		2.51 (0.93-6.72)	
Cardiorespiratory endurance				
Fit	1	0.048	1	0.038
Unfit	2.15 (0.98-4.75)		2.39 (1.05-5.44)	

Notes: OR = odds ratio; CI 95% = 95% confidence interval; [1] Adjusted for sex and age.

DISCUSSION

Finding significant proportion of adolescents who do not meet health criteria was not unique to this study, it has been routine in studies on the subject as evidenced by Andreasi et al.[18]. It has been emphasized that this fact does not mitigate the situation, otherwise, it warns for the need for attention to this population. There are several factors that contribute to this situation, and the main are reduced physical activity practices and increased time in sedentary behaviors, which were not measured in this study.

The lack of significant differences between sexes in body composition is a result not found in studies by Andreasi et al.[18], who found greater proportion of unfit girls and by Petroski et al.[19], who found greater unfitness in boys. Nevertheless, it is noteworthy that both groups showed high unfitness indexes and its consequences are already established in literature: association with high levels of cholesterol, triglycerides and high blood pressure[20].

Regarding flexibility, most adolescents did not reach the minimum criteria for health, and this outcome was more prevalent in males than in females ($p < 0.05$). However, there is lack of uniformity of results in literature in relation to this health-related physical fitness component. Low flexibility levels are worrying, especially due to the risks associated with low-back pain and higher incidence of postural deviations[21].

In the muscular strength component, the fact that boys have shown lower prevalence of unfitness ($p<0.05$) than girls does not make their situation less worrying, given that 90.2% did not reach the minimum levels established by AAHPERD[17]. It is common to find studies with advantage of boys in this component in literature. This trend of favorable results for boys in relation to muscle strength can be explained, in a way, by body size and muscle mass volume, since associations of these variables with strength and muscular endurance are positive[2].

Similar results between sexes found in relation to cardiorespiratory endurance do not prevail in literature, and it is possible to find studies with favorable outcomes for girls[14] and boys[18]. The differences observed in the outcomes of the various studies on to differences in cardiorespiratory fitness between sexes may be due, among other factors, to differences in maturational stages [2] according to the different age groups analyzed, different protocols used, and the different demographic and socioeconomic contexts.

Regarding academic performance, the area of natural sciences (Mathematics, Physics, Chemistry and Biology) showed the highest prevalence of adolescents who have not reached the average grade when compared with areas of Humanities and Languages and Codes. This result corroborates the results historically obtained by Brazilian students at the National High School Exam[22] (ENEM) created in 1998 and applied each year by the Ministry of Education in Brazil.

Analyzing the academic performance by sex, it was observed that there were no significant differences in area of Humanities. However, the male group showed higher prevalence ($p < 0.05$) of adolescents who have

not reached the average grade in the areas of Languages and Codes and Natural Sciences. This fact goes against the ENEM[22] results of 2014, in which boys had better scores than girls in all areas of knowledge. It is noteworthy that, historically, boys had better performances than girls. These results find support in the biologicist theory of Miller and Halpern[23], who advocate the superiority of women, arguing that many of the genes related to brain activities are located on the X chromosome - which women have two copies, and men only one. However, it is known that other aspects, such as social and cultural, can also contribute to this result.

The lack of association between body composition and academic performance presented in Table 3 corroborates the results found by researchers in the United States[24] and China[25]. However, other authors in the United States[7], Iceland[11] and Spain[12] found association between body composition and academic performance. This situation shows that the issue is not yet established in literature, and requires further studies.

There was also no association between flexibility and academic performance and these results are not in agreement with few studies[4,25], in which the authors investigated this health-related physical fitness component.

Regarding muscular strength, it was observed that without controlling possible confounding factors, there was association ($p = 0.034$) with academic performance; however, after adjustment for age and sex, the association disappears, corroborating studies[25-27] conducted in other countries.

The only health-related physical fitness component that was associated with academic performance, both before controlling for possible confounding factors ($p = 0.048$) and after adjustment for sex and age ($p = 0.038$), showing to be a consistent predictor for academic performance, was cardiorespiratory endurance. In is noteworthy that cardiorespiratory unfitness increases in nearly two and a half times the likelihood of poor academic performance.

Although few studies[26] have not found association between cardiorespiratory endurance and academic performance, a significant number of researchers[6-10,12] obtained results similar to those found in this study, showing a clear trend for this association.

Although our results do not report a causal relationship, it is known that high cardiorespiratory fitness levels exert influences on physiological factors related to academic performance[28]. There are at least three hypotheses about the mechanisms of physiological action of aerobic exercise on cognitive function[29]: (1) vascular disorders, with promotion of angiogenesis and increased blood flow in brain regions associated with cognition, (2) increased brain levels of neurotransmitters such as serotonin and noradrenaline, which facilitate information processing and (3) changes in the regulation of neurotrophins, influencing neurogenesis.

In addition, alternative explanations based on the psychosocial aspect have been formulated for the positive association between aerobic capacity and academic performance[30]: (1) the physical fitness of students is associated with better health, which can positively contribute to academic per-

formance, (2) physical activity and increased physical fitness can improve attention and behavior of students in the classroom, (3) physical activity can improve mental health and self-esteem, and (4) regular exercise can relieve stress, anxiety and depression, which can affect school performance. Thus, improving cardiorespiratory fitness can be an effective strategy to improve the school performance of this population.

CONCLUSION

There was an association between cardiorespiratory endurance, a health-related physical fitness functional component, and academic performance of adolescents, and being unfit in that component increased by twice the likelihood of poor academic performance.

Thus, actions that allow the regular practice (curricular and extracurricular) of physical exercise (especially aerobic) in the school environment are recommended, as this practice will improve physical fitness and can contribute to improve the academic performance of adolescents.

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REFERENCES

1. Mayer LCR, Böhme MTS. Verificação da validade de normas (em percentis) da aptidão física e de medidas de crescimento físico e composição corporal após 8 anos de elaboração. Rev Bras Ativ Fís Saúde 1996;1(4):5-18.
2. Malina RM, Bouchard C, Bar OR. Crescimento, maturação e atividade física. 2. ed. São Paulo: Phorte, 2009.
3. Hillman CH, Erickson KI, Kramer AF. Be smart, exercise your heart: Exercise effects on brain and cognition. Nat Rev Neurosci 2008;9(1):58-69.
4. Eveland-Seyers BM, Farley RS, Fuller DK, Morgan DW, Caputo JL. Physical fitness and academic achievement in elementary school children. J Phys Act Health 2009;6(1):99-104.
5. Tomporowski PD, Davis CL, Miller PH, Naglieri JA. Exercise and children's intelligence, cognition, and academic achievement. Educ Psychol Rev 2008;20(2):111-31.
6. Srikanth S, Petrie TA, Greenleaf C, Martin SB. The Relationship of Physical Fitness, Self-Beliefs, and Social Support to the Academic Performance of Middle School Boys and Girls. J Early Adolesc 2015;35(3):353-77.
7. Castelli DM, Hillman CH, Buck SM, Erwin HE. Physical fitness and academic achievement in third- and fifth-grade students. J Sport Exerc Psychol 2007;29(2):239-52.
8. Roberts C, Freed B, McCarthy W. Low aerobic fitness and obesity are associated with lower standardized test scores in children. J Pediatr 2010;156(5):711-8.
9. Huang T, Tarp J, Domazet SL, Thorsen AK, Froberg K, Andersen LB, et al. Associations of Adiposity and Aerobic Fitness with Executive Function and Math Performance in Danish Adolescents. J Pediatr 2015;167(4):810-5.
10. Kwak L, Kremers SPJ, Bergman P, Ruiz JR, Rizzo NS, Sjöström M. Associations between Physical Activity, Fitness, and Academic Achievement. J Pediatr 2009;155(6):914-8.

11. Kristjansson AL, Sigfudottir ID, Allegrante JP. Health Behavior and Academic Achievement Among Adolescents: The Relative Contribution of Dietary Habits, Physical Activity, Body Mass Index, and Self-Esteem. Health Educ Behav 2010;37(1):51-64.
12. Torrijos-Niño C, Martínez-Vizcaíno V, Pardo-Guijarro MJ, García-Prieto JC, Arias-Palencia NM, Sánchez-López MS. Physical Fitness, Obesity, and Academic Achievement in Schoolchildren. J Pediatr 2014;165(1):104-9.
13. Campos ALR, Sigulem DM, Moraes DEB, Escrivão AMS, Fisberg M. Quociente de inteligência de crianças e adolescentes obesos através da escala Wechsler. Rev Saude Publica 1996;30(1):85-90.
14. Santana CCA. Associação entre estado nutricional, aptidão física e desempenho escolar em estudantes. Recife (PE). Dissertação [Mestrado em Educação Física] – Universidade de Pernambuco/ Universidade Federal da Paraíba; 2012.
15. Luiz RR, Magnanini MMF. A lógica da determinação do tamanho da amostra em investigações epidemiológicas. Cad Saúde Colet 2000;8(2):9-28.
16. International Society for the Advancement of Kineanthropometry (ISAK). International Standards for Anthropometric Assessment. Underdale, 2001.
17. American Alliance for Health, Physical Education, Recreation and Dance (AAHPERD). Physical best. Reston: 1988.
18. Andreasi V, Michelin E, Rinaldi AEM, Burini RC. Aptidão física associada às medidas antropométricas de escolares do ensino fundamental. J Pediatr 2010;86(6):497-502.
19. Petroski EL, Fernandes da Silva A, Bispo Rodrigues A, Pelegrini A. Aptidão física relacionada a saúde em adolescentes brasileiros residentes em áreas de médio/baixo índice de desenvolvimento humano. Rev Salud Pública 2011;13(2):219-228.
20. Eisenmann JC, Welk GJ, Ihmels M, Dollman J. Fatness, fitness, and cardiovascular disease risk factors in children and adolescents. Med Sci Sports Exerc 2007;39(8):1251-6.
21. Mikkelsson LO, Nupponen H, Kaprio J, Kautiainen H, Mikkelsson M, Kujala UM. Adolescent flexibility, endurance strength, and physical activity as predictors of adult tension neck, low back pain, and knee injury: a 25 year follow up study. Br J Sports Med 2006;40(2):107-13.
22. Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira (INEP). Resultados do Exame Nacional do Ensino Médio 2014. Brasília, 2015.
23. Miller DI, Halpern DF. The new science of cognitive sex differences. Trends in Cogn Sci 2014;18(1):37-45.
24. Rauner RR, Walters RW, Avery M, Wanser TJ. Evidence that Aerobic Fitness Is More Salient than Weight Status in Predicting Standardized Math and Reading Outcomes in Fourth- through Eighth-Grade Students. J Pediatr 2013;163(2):334-48.
25. Chen L-J, Fox KR, Ku P-W, Taun C-Y. Fitness change and subsequent academic performance in adolescents. J Sch Health 2013;83(9):631-8.
26. Ruiz JR, Ortega FB, Castillo R, Martín-Matillas M, Kwak L, Vicente-Rodríguez G, et al. Physical activity, fitness, weight status, and cognitive performance in adolescents. J Pediatr 2010;157(6):917-22.
27. Edwards JU, Lois Mauch RD, Winkelman MR. Relationship of nutrition and physical activity behaviors and fitness measures to academic performance for sixth graders in a Midwest city school district. J Sch Health 2011;81(2):65-73.
28. Fedewa AL, Ahn S. The effects of physical fitness on children`s achievement and cognitive outcomes: a meta-analysis. Res Q Exerc Sport 2011;82(3):521-35.
29. Lojovich JM. The relationship between aerobic exercise and cognition: is movement medicinal? J Head Trauma Rehabil 2010;25(3):184-92.
30. Biddle SJ, Asare M. Physical activity and mental health in children and adolescentes: a review of reviews. Br J Sports Med 2011;45(11):886-95.

CORRESPONDING AUTHOR

Fábio Jorge Santos de Castro
Rua Construtor Genival Maciel, nº 550, casa 29, Condomínio La Villette, Coroa do Meio, Aracaju, Sergipe, Brasil.
CEP: 49.036-090
Email: fabiokstro@hotmail.com