Rev Bras Cineantropom Desempenho Hum

original article

https://doi.org/10.1590/1980-0037.2023v25e94396

Physical and motor profile of children between 6 and 10 years old according to levels of cardiorespiratory fitness

Perfil físico e motor de crianças entre os 6 e os 10 anos de idade em função dos níveis de aptidão cardiorrespiratória

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Abstract – This study aimed to compare the physical profile and motor profile of children from 6 to 10 years old, according to their level of cardiorespiratory fitness (CRF). Participated 2036 children from 6 to 10 years old from São José dos Pinhais - PR. Assessed variables were stature, corporal mass, Body mass index (BMI), physical fitness (PF), and gross motor coordination (GMC). The CRF was assessed by the total distance during the 6 minutes walking test. A battery of tests KTK evaluated the GCM. The children were classified according to their levels of CRF (low-moderate-elevated). Differences between groups were tested using ANOVA one way. Data analysis was made in the SPSS software, with a meaningfulness of 5%. Children with low levels of CRF showed higher values of adiposity. On the PF tests, children with low levels of CRF showed higher values of prehension and worse performance in the other tests. Regarding GMC, children with low levels of CRF had lower coordinative performance. Meaningful differences were found in the comparisons between different groups (low-moderate, low-elevated) with an advantage in the results in moderate levels of CRF. Obtaining average levels of CRF can bring protective benefits in other variables in children's growth process and development during infancy. Evaluating the CRF doesn't only get a momentary evaluation. Still, it can also do the monitoring of an essential variable of health, as well as indicate a predisposition about other physical-motor variables.

Key words: Cardiorespiratory fitness; Physical fitness; Motor coordination.

Resumo – *Comparar o perfil físico e motor de crianças dos 6 aos 10 anos, conforme os seus níveis de aptidão cardiorrespiratória (AptC). Participaram do estudo 2036 crianças de seis a 10 anos de idade de São José dos Pinhais-PR. Foram avaliados estatura, massa corporal, índice de massa corporal (IMC), aptidão física (AptF) e coordenação motora (CMG). A AptC foi avaliada pela distância total percorrida no teste de seis minutos. A CMG foi avaliada por meio da bateria de testes KTK. As crianças foram classificadas em função dos níveis de AptC (baixo-moderado-elevado). Diferenças entre grupos foram testadas utilizando da ANOVA* one way. *As análises dos dados foram realizadas no* software *SPSS, com nível de significância em 5%. Crianças com menor nível de AptC apresentam maiores valores médios adiposidade. Nos testes de AptF, crianças com níveis baixos de AptC apresentaram maiores valores de preensão e pior desempenho nos demais testes. Relativamente à CMG, crianças com baixos níveis de AptC apresentaram piores desempenho coordenativo. Diferenças significativas foram encontradas para as comparações entre os outros grupos (baixo-moderado; baixo-elevado) com vantagem nos resultados nos níveis moderados a elevados de AptC. Obter níveis moderados de AptC pode trazer benefícios protetores em diferentes variáveis do processo de crescimento e desenvolvimento de crianças durante a segunda infância. Avaliar a AptC não traz somente uma avaliação momentânea, como pode ser feito o monitoramento de uma importante variável de saúde bem como indicar uma predisposição sobre outras variáveis físico-motoras.*

Palavras-chave: *Aptidão cardiorrespiratória; Aptidão física; Coordenação motora.*

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Received: May 18, 2023
Accepted: June 26, 2023

How to cite this article
Nascimento ÉM, Chaves RN, Rodriguez-Añez CR, Ribas MCS. Physical and motor profile of children between 6 and 10 years old according to levels of cardiorespiratory fitness. Rev Bras Cineantropom Desempenho Hum 2023, 25:e94396. DOI: https://doi.org/10.1590/1980-0037.2023v25e94396

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INTRODUCTION

The physical fitness (PF) refers to a group of physical-motor characteristics that are related to the capacity of a person accomplishing a physical activity, being cardiorespiratory fitness (CRF) one of the main components[1,2]. The CRF is the capacity of accomplishing dynamic exercise of moderate to vigorous intensity, with large muscular groups, for long periods. The CRF an important health marker in the pediatric context[3,4].

The infancy period is characterized by expressive changes due to essential alterations in bodily structures and physical conditioning[5,6]. The levels of CRF are crucial mediators in a healthy lifestyle since infancy. Children and teenagers with high levels of cardiorespiratory markers tend to be more protected from risk factors of cardiovascular diseases (obesity, hypertension, dyslipidemia, and insulin resistance)[1,3,7,8]. Prospective studies showed that high values of CRF in children and teenagers are associated with a healthier cardiovascular state in adulthood[3].

Among the factors associated with levels of CRF in children in their school phase are biological and behavioral factors, which stand out factors like genetics[1], gender, age[9], and weight status[10]. Studies report the difference between genders, suggesting that boys are fitter in PF tests than girls[9].

Concerning weight, studies point out that in CRF tests, children with adequate weight obtain meaningly better punctuation than their pairs with overweight or obesity[1,9,11]. Other measures related to adiposity, including larger waist circumference and body fat percentual, are negatively correlated to CRF[9,12].

Stodden et al.[13] suggest a model framework that illustrates synergistic and reciprocal relations between physical activity, PF, and motor coordination, among other factors. In the last decades, articles leaned over the comprehension of these associations and corroborated this proposal[14-17], evidencing that CRF is positively associated with motor competence during infancy. And this can have an important impact on positive engagement in children's health posteriorly.

A significant part of the available information about the growth and development of children in second infancy analyses these interrelations in isolation. The assessment of the physical and motor profile of children in different subgroups of CRF can enhance the comprehension about deleterious or potential benefit relations of satisfactory levels of CRF during second infancy. Besides that, results would assist professionals to intervene in the school context, as well as those seeking to obtain more information about CRF evaluation.

METHOD

This is a school-based cross-sectional study that uses partial data of project called "Growth, Development, Physical Education and Health: A Study with the Scholars of São José dos Pinhais PR". This project was held as part of the "Active City, Healthy City Program of the secretary of Sports and Leisure of São José dos Pinhais, implemented by the Research Group of Environment, Physical Activity and Health of Universidade Tecnológica Federal do Paraná (UTFPR). Informed consent was obtained from parents or legal guardians and the participants themselves before the beginning of assessments (Ethical board registration number 3.365.489).

Participation selection was held using as a primary unit of sampling the schools. Twenty out of 50 schools were selected using as criteria the proximity to Center of Sports and Leisure (NEL). The NEL's are facilities administered by the

Municipal Secretary of Sports and Leisure with structures for physical activities. In rural areas, were selected 5 out of 7 schools. Each selected school, a class of each year (1st - 5th grade) was invited to participate, totaling five classes per school.

The sample was 2036 children (1046 girls, 990 boys) between 6 and 10 years old. The losses occurred by the non-acceptance or non-devolution of the signed informed consent. The exclusions were carried out by non-participation in one or more tests. Assessments were performed between April and August of 2019 by a group of trained researchers constituted by academics and professionals of physical education members of the Research Group of Environment, Physical Activity and Health of UTFPR.

Anthropometry

Were evaluated the anthropometric variables of stature (cm), corporal mass (kg), and waist circumference (cm). The BMI was calculated from the equation BMI=weight(kg)/height(m^2)). All the measurements were made following the protocols of the International Society for the Advancement of Kinanthropometry[18].

Physical fitness

The children performed a set of tests from the AAHPER Youth Fitness Test battery[19], adapted following orientations from PROESP-BR to evaluate the PF. PF assessed variables were: speed evaluated by 20 meters run (R20m); horizontal jump evaluated by standing long jump test (SLJ); hand grip strength (HG) assessed with a dynamometer on favorite hand; agility evaluated by shuttle-run test of 9 meters course (SHR). These tests were used to assess the levels of PF in pediatric populations.

The CRF was evaluated using 6 minutes walking test on a course marked at every 3 meters without obstacles, children were oriented to walk or run in their rhythm for 6 minutes and recorded the distance traveled during the 6 minutes. For data treatment, the absolute values were adjusted by each age and gender, and results were grouped in tertials (low <33; moderate 33 to <66; elevated≥66).

Motor coordination

Gross motor coordination (GMC) was assessed by the Köperkoordinationtest für Kinder (KTK) battery. The KTK has four tests: walking backwards on balance beams (WB); hopping for height on one leg (HH); jumping sideways (JS) and moving sideways (MS). The present study obtained the non-weighted sum of scores of the four tests as one global measurement of GMC, according to Schilling[20].

For data analysis exploratory statistics were performed to verify entrance's mistakes and the occurrence of outliers, as well as test the normality of the data. Descriptive statistic was used to characterize the sample, and the test for independent samples was used to compare variables between genders. The analysis of variance (ANOVA) was used to accomplish variables between the groups of CRF, according to gender and age. Bonferrroni Post Hoc was used to test differences between groups. Charts of score-z were used to point the physical and motor profile of subgroups of CRF subdivided in gender and adjusted for age. All analyses were accomplished in SPSS software, and the level of meaningfulness was assumed to be 5%.

RESULTS

The statistics of physical and motor profiles are presented in Table 1. In general, with the advance of age, both girls and boys increase mean-values of stature measurements, corporal mass, BMI, waist circumference, and variables referring to PF and GMC. The result presents meaningful differences between genders for the tests of PF, where boys present a better performance in all tests of PF, including CRF, along all second infancy. In motor coordination tests, all girls showed better values only in WB test between six and eight years old. In general, boys obtained higher values in tests of HH, JS, MS, and the total sum.

Table 2 presents the characteristics of girls and boys from 6 to 10 years old according to different levels of CRF. It is possible to observe that children with an elevated level of CRF were smaller, with significant differences for the stature of boys between 6, 8, and 10 years old. It is noted that boys and girls classified with low levels of CRF presented higher values for weight, BMI, and waist circumference. Comparisons regarding levels of CRF show meaningful differences, mainly between low-moderate and low-elevated groups (p<0.05).

Table 3 compares the motor coordination profile of girls and boys from 6 to 10 years old according to the different levels of CRF. Children with elevated levels of CRF, above all moderate and elevated, present lower prehension values, higher distance in SLJ, and better performance in SHR and R20m tests.

Regarding to GMC, children with highest levels of CRF presented a better performance in tests of WB, JS, MS, as well as in the total sum of global GMC. Meaningful differences also were found in comparisons between other groups, always with an advantage for the motor performance of children with moderate levels of CRF. The Figure 1 presents Z-score of data of physical-motor variables rate between groups of CRF.

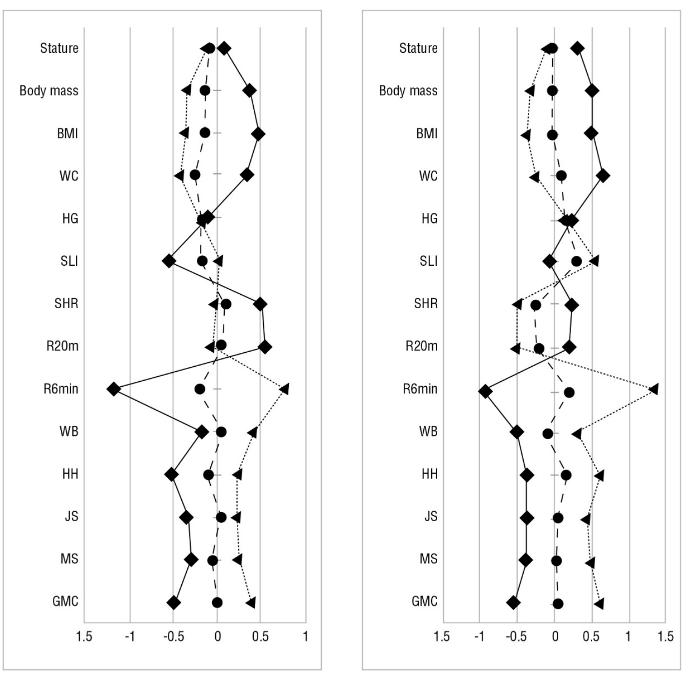

Figure 1. Z-score of data of physical-motor variables rate between groups of CRF. ◄: elevated level of CRF; ●: moderate level of CRF; ◆: low kever of CRF; BMI: body mass index; WC: waist circumference; HG: hand grip strenght; SLJ: long jump; SHR: shuttle-run; R20m: 20 meters run; R6min: 6 minutes run; WB: walking backwards; HH: hoping for height; JS: jumping sideways; MS: moving sideways; GMC: gross motor coordination.

Table 1. Descriptive measurements in function of age and gender.

		6 years		7 years		8 years		9 years		10 years	
		Mean ± SD	Min / Max	Mean ± SD	Min / Max	Mean ± SD	Min / Max	Mean ± SD	Min / Max	Mean ± SD	Min / Max
Stature (cm)	♀	118.9±4.9	103.0/137.4	125.5±5.6	109.0/146.0	130.4±6.1	111.8/146.1	136.4±5.8	122.2/151.1	142.8±6.5	127.3/159.4
	♂	**120.2±5.3**	107.0/134.0	126.2±6.1	108.2/143.3	**132.0±6.03**	115.0/151.0	136.6±5.9	121.3/151.0	141.7±6.7	121.6/163.5
Weight (kg)	♀	23.2±4.6	15.3/41.1	26.6±5.5	15.5/44.9	29.2±6.1	17.3/49.4	34.3±7.7	22/61.1	40.2±11.0	23.9/87.7
	♂	24.0±4.1	16.5/38.4	26.5±4.9	17.7/41.5	**31.5±8.0***	15.0/64.9	34.6±7.8	22.5/70.7	39.0±11.2	22.8/98.9
BMI (kg/m²)	♀	16.4±2.5	11.8/25.7	16.9±2.7	10.5/27.1	17.0±2.7	11.8/28.5	18.2±3.3	13.8/30.8	19.5±4.2	14.2/35.6
	♂	16.5±2.0	12.6/24.4	16.7±2.2	13.1/25.5	**17.9±3.6***	10.5/31.7	18.3±3.3	13.0/35.4	19.1±4.0	12.5/37.0
WC (cm)	♀	54.1±5.5	45.5/74.0	56.5±6.4	45.9/77.0	57.2±5.9	46.8/80.0	60.1±7.9	48.1/89.1	63.5±8.9	49.4/96.9
	♂	**55.7±5.4***	41.9/79.0	57.6±6.3	48.1/90.1	**60.8±8.5***	49.9/99.1	**62.3±8.2***	33.5/94.3	64.7±9.7	50.0/102.0
HG (kg/F)	♀	9.0±1.9	3.9/14.8	11.0±2.6	5.8/20.8	12.5±2.9	5.7/20.0	14.3±3.3	7.0/26.0	16.7±3.4	9.9/27.5
	♂	**9.7±1.9***	5.0/14.6	**11.8±2.6***	5.0/20.5	**13.4±2.8***	7.1/22.8	**15.7±3.4***	7.1/23.8	**17.8±3.8***	9.5/28.8
SLJ (cm)	♀	83.4±17.9	37.9/144.1	91.0±18.9	52.0/138.2	100.6±18.9	45.7/167.0	103.9±21.2	56.8/165.0	109.1±19.3	58.5/160.0
	♂	**93.0±22.2***	26.8/150.0	**101.0±18.4***	48.6/160.0	**109.5±20.7***	42.0/177.5	**117.1±23***	60.9/175.0	**122.7±25.2***	45.0/178.0
SHR (sec)	♀	16.2±1.6	12.2/20.1	15.1±1.5	11.7/19.2	14.6±1.4	10.8/19.7	14.3±1.3	11.2/18.3	13.7±1.3	10.7/20.8
	♂	**15.6±1.6***	11.6/20.3	**14.6±1.6***	9.7/20.7	**14.2±1.5***	10.2/18.7	**13.6±1.5***	10.7/18.5	**13.3±1.5***	10.1/19.9
R20m (sec)	♀	5.4±0.7	3.9/8.7	5.0±0.5	3.3/6.9	4.8±0.5	3.5/6.4	4.7±0.4	3.6/6.5	4.6±0.5	3.3/6.7
	♂	**5.1±0.6***	3.7/7.4	**4.8±0.5***	3.7/6.3	**4.7±0.5***	3.3/6.4	**4.8±0.5***	3.3/6.7	**4.3±0.5***	3.1/6.6
R6min (m)	♀	708.2±100.5	450.0/983.6	730.8±11.2	411.6/1034.0	747.5±101.1	439.5/1070.8	752.7±114.5	402.9/1056.6	780.9±116.1	390.0/1060.2
	♂	**757.4±107.3***	450.0/1084.0	**777.4±120.9***	440.0/1151.0	**784.1±132.6***	415.1/1090.4	**830.1±129.6***	477.1/1173.0	**839.2±147.2***	367.9/1203.9
WB (points)	♀	**24.0±12.5***	1/61	**30.2±13.9***	3/72	**34.5±14.0***	5/69	37.6±14.2	7/72	40.5±14.6	3/72
	♂	20.1±12.5*	1/54	26.6±13.1	1/60	30.6±15.0*	2/72	36.8±15.0	3/72	39.6±16.0	7/72
HH (points)	♀	22.1±10.5	3/51	28.6±12.8	5/66	33.6±12.6	6/67	38.0±14.1	3/75	43.5±15.2	4/72
	♂	**24.8±11.9***	4/63	**31.1±12.1***	3/60	35.5±16.1	4/78	**44.3±15.3***	7/78	**50.6±15.6***	7/78
JS (points)	♀	31.1±9.5	9.67	38.2±10.0	19/69	42.9±11.4	18/81	46.9±12.6	16/84	52.1±10.8	7/75
	♂	**33.6±9.2***	14/59	37.7±9.9	13/65	42.5±12.2	15/72	**49.6±13.8***	14/86	52±13.3	12/85
MS (points)	♀	28.7±5.7	11/47	30.9±5.4	15/48	32.9±6.8	11/62	34.6±7.0	17/58	36.4±6.7	16/54
	♂	28.8±5.9	9/46	31.3±6.2	11/52	32.9±6.7	12/52	**36.1±7.7***	14/69	**38.1±7.5***	14/59
GMC (points)	♀	105.2±28.1	46/189	127.4±31.6	51/207	142.2±35.9	11/226	156.8±37.0	63/239	170.5±39.7	25/239
	♂	106.9±28.9	37/169	126.7±31.2	49/198	140.4±40.7	8/242	**166.6±40.8***	51/260	178.5±43.7	29/257

*Meaningful difference between genders ($p<0.05$); SD: standard deviation; Min: minimum; Max: maximum; ♀ girls; ♂ boys; BMI: body mass index; WC: waist circumference; HG: hand grip strengh; SLJ: long jump; SHR: shuttle-run; R20m: 20 meters run; R6min: run of 6 minutes; WB: walking backwards; HH: hoping for height; JS: jumping sideways; MS: moving sideways; GMC: gross motor coordination.

Table 2. Comparisons of differences on anthropometrical variables by age between groups of CRF.

	Sex	6 years			7 years			8 years		
		Low	Moderate	Elevated	Low	Moderate	Elevated	Low	Moderate	Elevated
		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Stature (cm)	♀	119.6±5.3	119.2±4.4	118.9±4.9	126.4±5.6	125.3±5.2	124.6±5.9	131.3±6.0	129.4±5.5	130.6±6.7
	♂	**121.7±5.5c**	119.8±5.6	**119.2±4.4**	**127.7±5.7c**	126.3±6.4	**124.6±6.0**	**134.0±6.5bc**	**130.8±5.7**	**131.2±5.2**
Weight (kg)	♀	**24.9±5.9bc**	**22.87±3.48**	**22.0±3.3**	**28.8±6.5bc**	**26.4±4.9**	**24.7±4.2**	**31.4±6.8bc**	**28.3±5.6**	**27.9±5.2**
	♂	**25.1±4.3c**	24.13±4.26	**22.8±3.4**	**28.5±5.4c**	**26.8±5.1c**	**24.5±3.2**	**36.9±9.8bc**	**29.4±5.9**	**28.6±5.1**
BMI (kg/m²)	♀	**17.4±3.3bc**	**16.0±2.0**	**15.7±1.7**	**18.3±3.2bc**	**16.7±2.4**	**15.9±2.0**	**18.0±3.1bc**	**16.8±2.5**	**16.2±2.0**
	♂	**17.0±2.3c**	16.6±1.9	**16.0±1.6**	**17.6±2.6c**	**16.8±2.1c**	**15.7±1.2**	**20.4±4.3bc**	**17.0±2.4**	**16.5±2.4**
WC (cm)	♀	**56.3±7.2bc**	**53.5±4.6**	**52.4±3.2**	**59.3±7.0bc**	**55.7±5.6**	**54.5±5.4**	**59.5±6.9bc**	**56.3±5.4**	**55.8±4.5**
	♂	**57.6±6.4c**	55.4±4.9	**54.2±4.0**	**59.6±7.3c**	**58.6±6.9c**	**54.6±2.9**	**66.8±10.6bc**	**58.5±5.3**	**57.1±4.9**

	Sex	9 years			10 years		
		Low	Moderate	Elevated	Low	Moderate	Elevated
		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Stature (cm)	♀	136.9±6.1	135.7±5.7	136.6±5.7	143.9±6.8	143.0±6.1	141.6±6.6
	♂	136.9±6.0	136.9±5.9	136.0±5.6	**144.3±7.7bc**	**140.4±6.4**	**140.6±5.0**
Weight (kg)	♀	**38.2±8.6bc**	**33.2±7.6**	**31.6±5.0**	**45.7±13.5bc**	**39.2±9.1**	**35.8±7.3**
	♂	**37.9±9.4bc**	**34.4±7.0**	**31.7±5.2**	**45.3±14.9bc**	**38.2±7.8**	**33.6±5.4**
BMI (kg/m²)	♀	**20.2±3.9bc**	**17.6±2.6**	**16.8±2.0**	**21.8±5.2bc**	**19.0±3.5**	**17.7±2.4**
	♂	**19.8±4.0bc**	**18.2±3.0ac**	**17.0±1.9**	**21.3±5.2bc**	**19.2±3.1ac**	**16.9±2.0**
WC (cm)	♀	**64.3±9.4bc**	**58.9±7.0**	**57.2±4.8**	**68.4±10.7bc**	**62.4±7.8**	**59.9±5.4**
	♂	**66.2±9.3bc**	**61.8±8.1**	**59.1±5.1**	**69.6±12.2bc**	**64.7±8.1ac**	**59.8±4.7**

SD: standard deviation; ♀ girls; ♂ boys; BMI: body mass index; WC: waist circumference; a: p<0.05 for low level of CRF; b: p<0.05 for moderate level of CRF (p<0.05); c: p<0.05 for elevated level of CRF.

Table 3. Comparisons of differences on physical-motor variables by age between groups of CRF.

	Sex	6 years			7 years			8 years		
		Low	Moderate	Elevated	Low	Moderate	Elevated	Low	Moderate	Elevated
		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
HG (kg/F)	♀	9.1±1.8	9.2±1.9	8.8±2.0	11.3±2.8	11.1±2.7	10.7±2.3	12.3±3.1	12.5±2.7	12.5±2.7
	♂	9.6±1.9	9.9±2.2	9.7±1.5	12.2±2.9	11.6±2.5	11.5±2.3	13.7±3.0	12.9±3.0	13.7±2.6
SLJ (cm)	♀	**78.1±16.2c**	84.9±17.7	**87.5±18.7**	**82.4±16.0bc**	**94.8±17.6**	**95.5±20.0**	**92.5±14.4bc**	**103.1±17.8**	**105.8±21.3**
	♂	**84.0±21.0bc**	**97.6±20.8**	**97.3±22.4**	98.7±20.8	98.9±18.2	105.3±15.6	**101.1±19.5bc**	**112.2±16.6**	**114.9±23.2**
SHR (sec.)	♀	**16.6±1.5b**	**15.9±1.7**	16.0±1.6	15.5±1.7	15.1±1.4	14.9±1.4	**15.2±1.2bc**	**14.3±1.4**	**14.2±1.4**
	♂	**16.4±1.6bc**	**15.4±1.7**	**15.1±1.3**	**15.2±2.0c**	14.5±1.4	**14.2±1.3**	**14.6±1.5c**	14.1±1.5	**13.8±1.3**
R20m (sec.)	♀	**5.6±0.8bc**	**5.2±0.7**	**5.3±0.5**	**5.1±0.5c**	4.9±0.6	**4.9±0.4**	**5.0±0.5bc**	**4.8±0.4**	**4.7±0.4**
	♂	**5.3±0.6bc**	**5.0±0.5**	**4.9±0.5**	**4.9±0.4c**	**4.8±0.4c**	**4.6±0.4**	**5.0±0.5bc**	**4.7±0.4**	**4.5±0.4**
WB (points)	♀	**20.7±12.5c**	23.8±12.4	**27.5±12.0**	**27.2±14.7c**	29.3±13.4	**33.9±12.9**	**30.0±13.6c**	**34.5±12.4**	**38.9±14.6**
	♂	**15.3±11.1c**	20.2±13.1	**24.7±11.7**	**23.0±13.1c**	26.1±13.2	**30.4±12.2**	**22.6±11.8bc**	**31.0±12.6ac**	**37.7±16.2**
HH (points)	♀	19.7±9.3	22.8±10.0	23.8±11.7	**25.2±11.6c**	**26.5±12.1c**	**33.9±12.9**	**27.2±10.2bc**	**34.9±13.5**	**38.2±11.29**
	♂	**17.7±11.4bc**	**25.6±10.8ac**	**30.8±10.0**	**26.4±12.5bc**	**32.4±10.8**	**34.3±11.6**	**27.6±13.3bc**	**35.8±16.3ac**	**42.6±15.0**
JS (points)	♀	**29.1±9.9c**	31.2±7.6	**33.0±10.3**	**35.7±9.1c**	37.7±9.9	**41.0±10.4**	**37.8±10.2bc**	**44.5±10.5**	**46.1±11.8**
	♂	**28.5±8.5bc**	**35.9±8.7**	**36.2±8.3**	**34.2±9.0c**	37.5±9.4	**41.4±10.1**	**37.6±10.9c**	**42.2±12.2c**	**47.4±11.5**
MS (points)	♀	**27.4±4.5c**	28.8±5.7	**29.8±6.4**	**30.0±4.9c**	30.9±5.9	**31.8±5.1**	**30.3±6.7bc**	**33.4±7.2**	**34.9±5.5**
	♂	**26.6±6.2c**	**28.2±5.3c**	**31.5±5.2**	29.8±5.6	30.9±6.2	33.3±6.3	**30.3±6.6bc**	**33.2±6.7**	**35.0±6.2**
GMC (points)	♀	**96.3±25.6c**	106.1±26.2	**113.5±29.9**	**116.6±31.5c**	**124.6±30.7c**	**140.7±28.2ab**	**122.0±34.2bc**	**147.6±30.0**	**156.6±34.4**
	♂	**87.3±28.2bc**	**109.8±24.9ac**	**123.4±20.9**	**113.6±31.6bc**	**126.5±29.7ac**	**139.5±27.1**	**116.4±35.7bc**	**140.6±36.7ac**	**162.8±36.2**

Table 3. Continued...

	Sex	9 years			10 years		
		Low	Moderate	Elevated	Low	Moderate	Elevated
		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
HG (kg/F)	♀	14.5±3.6	13.6±2.8	14.9±3.5	17.2±3.2	16.6±3.8	16.1±3.0
	♂	15.7±3.4	16.0±3.4	15.6±3.3	17.3±3.8	17.5±3.7	18.4±3.9
SLJ (cm)	♀	**96.3±18.4c**	103.6±20.9	**111.3±21.6**	**104.4±19.8c**	108.3±17.7	**114.4±19.2**
	♂	**108.8±22.3bc**	**117.8±22.5**	**124.4±21.8**	**115.4±28.6c**	121.1±21.3	**131.4±23.0**
SHR (sec.)	♀	**14.9±1.4bc**	**14.3±1.2ac**	**13.7±1.1**	14.0±1.6	13.5±1.0	13.6±1.3
	♂	**14.3±1.6bc**	**13.4±1.2**	**13.1±1.4**	**13.9±1.7bc**	13.2±1.4	**12.7±1.0**
R20m (sec.)	♀	**4.9±0.5bc**	**4.7±0.3ac**	**4.5±0.3**	4.8±0.7	4.5±0.4	4.5±0.4
	♂	**4.7±0.6bc**	**4.5±0.5**	**4.4±0.4**	**4.6±0.6bc**	4.3±0.5	**4.0±0.4**
WB (points)	♀	**33.4±12.9c**	37.0±15.3ac	**42.1±12.9**	**36.5±15.1c**	**39.1±13.1c**	**45.7±14.3**
	♂	**30.7±13.0bc**	**36.2±14.4ac**	**43.3±14.9**	**32.9±15.8c**	39.4±15.0	**46.3±14.5**
HH (points)	♀	**29.2±12.2bc**	**39.5±12.9ac**	**44.9±12.5**	**35.9±14.6bc**	**44.4±13.5**	**49.4±14.7**
	♂	**36.4±13.3ab**	**44.5±15.5ac**	**51.6±12.2**	**42.0±16.5bc**	**49.1±14.8ac**	**59.9±9.6**
JS (points)	♀	**41.7±12.3bc**	47.8±12.2	**50.9±11.7**	**49.1±12.9c**	53.0±10.0	**54.0±9.0**
	♂	**44.1±14.0ab**	**49.2±12.3ac**	**55.3±12.9**	**47.4±14.3c**	51.4±11.7	**57.2±12.1**
MS (points)	♀	**32.2±7.0c**	**34.0±6.3c**	**37.5±6.6**	**34.8±7.0c**	**35.5±5.6c**	**38.9±6.9**
	♂	**33.0±6.9c**	**35.8±7.6c**	**39.4±4.4**	**33.5±7.5bc**	**38.7±6.9ac**	**42.2±5.6**
GMC (points)	♀	**135.8±34.5bc**	**158.4±35.2ac**	**175.5±30.3**	**150.1±47.3bc**	**172.1±28.9**	**188.2±31.4**
	♂	**143.5±36.4bc**	**165.7±38.3ac**	**189.8±34.1**	**151.3±47.2bc**	**178.8±36.4ac**	**204.8±28.2**

SD: standard deviation; ♀ girls; ♂ boys; HG: hand grip strength; SLJ: long jump; SHR: shuttle-run; R20m: run of 20 meters; WB: walking backwards; HH: hoping for height; JS: jumping sideways; MS: moving sideways; GMC: Gross motor coordination; a: p<0.05 for low level of CRF; b: p<0.05 for moderate level of CRF (p<0.05); c: p<0.05 for elevated level of CRF.

DISCUSSION

The goal of this study was to describe and compare the physical and motor profile of children from 6 to 10 years old, according to their level of CRF. Over all, girls and boys increase mean values of stature, corporal mass, BMI, and waist circumference, as well as variables referring to PF and GMC over the years. These changes are expected, and well consolidated in literature[5].

Boys usually shows small advantages in their mean values for physical-motor variables, in each matter of age, relative to girls. The girls had advantages only in mean values of WB. These data corroborate the evidence of literature[5,21-23]. The gender dimorphism in anthropometric variables and physical motor can be explained by the differences in corporal size, in development of muscular mass, and behavioral aspects related to the opportunity of the practice of physical activity[5,24].

Concerning to the groups of CRF and comparison of anthropometrical variables, children with a low level of CRF present higher values for weight, BMI, and waist circumference. Literature reports a strong association between low aerobic fitness and excess corporal adiposity[11,15,25], whose explanation suggests that individuals with excess of weight due to excess of corporal fat tend to present difficulties of locomotion, decrease in the frequency walking strides, less stability during a walk or run and reduction of aerobic capacity[26]. Low levels of CRF associated with excess of corporal adiposity during infancy can potentially form a "cluster" of risk factors that enhances the child's exposure to a negative spiral of development and deleterious health conditions. Once levels of CRF and adiposity present a tendency of stability overall after the second infancy, these results are alarming and require a more careful look from professionals of health and education, as well as from parents or legal guardians of the children[25,26].

Regarding profile of PF, children with low levels of CRF presented higher values of HG, more downward distance in SLJ, and higher times for accomplishment of runs SHR and R20m. Besides that, children presented high values of corporal adiposity, which can damage the performance in tasks of fast displacements[25]. Similar results were found in other studies[27,28]. Souza et al.[28] evidenced the importance of stability and maintenance of healthy behavior during second infancy. They showed that children classified with elevated CRF and more active at 10 years old, already presented better development of PF in their 6 years old when compared to their pairs less physically fit. In this sense, children with low levels in tests that mark different components of physical fitness are more susceptible to the maintenance of this condition along their process of growth and development, because of minor encouragement, motivation, and effective participation in more intense physical activities or sporty character[23]. It is essential to highlight that components of PF relate during growth, representing an essential construct of life quality already during infancy[1].

Regarding motor coordination, children with moderate and high levels of CRF present better performances in different tests of coordination, as well as a global measurement of GMC, except in balance. Previous studies indicate that CRF is positively associated with aspects of GMC[13-15,24]. The advantage in higher levels of CRF and GMC tests can be explained by biological factors and by more extensive refinement of motor habilities[14,29,30]. In addition, the tasks accomplished in GMC tests demand strength, agility, speed, a high degree of coordination, and intramuscular control, emphasizing the idea of a dynamic relation between GMC and PF[14]. In this sense, children with higher levels of CRF and GMC are predisposed to a more positive development trajectory, marked by a more extensive engagement in physical activities and sports inside and outside the school environment[13,14].

From a general analysis of results, the found suggest a critical point: in a larger share of the data, differences were found for comparisons between low-moderate and low-elevated groups, always evidencing an advantage on the physical and motor profile of children with moderate levels and, above all elevated levels of CRF. In this sense, moderate to high levels of CRF are more associated with a physical and motor profile that is healthier. This emphasizes the relevance of obtaining good levels of CRF for a development cycle more favorable in the second infancy with possible maintenance in the following phases.

This study presents some limitations: (i) its design doesn't allow inferences over the causality of CRF, physical and motor profile; however, the study deals with phenomenon of development and could demonstrate a relation that keeps through time, according to the proposed by Stodden et al.[13]; (ii) an indirect measurement evaluated the CRF; therefore, literature reports that the 6-minute run is validated and widely used in school-based studies; (iii) all evaluated schools were public and from one city; however, there was concern from the researchers in accomplishing the study in urban and rural regions.

Although there are limitations, the present study strengths as (i) it is about a large sample of children in an extended school area (25 schools); (ii) it shows variables that mark aspects of growth and development, as well as point out a larger landscape of the possible factors correlated to levels of CRF in children; (iii) the tests and protocols used in this research are widely used and validated worldwide; (iv) the subgroups present an essential source of information referring to levels of CRF that can help teachers and health professionals to understand the physical-motor profile in second infancy.

CONCLUSION

Children with higher levels of CRF shows better values in the assessed physical-motor variables. The differences found in comparisons between the groups of low/moderate and low/elevated CRF, showed it is always evident the advantage in the physical and motor profile of children with moderate and high levels of CRF. Obtaining, at least, average levels of CRF can bring protective benefits in different variables of growth and development of children during second infancy. In this sense, it is essential to encourage active playing, replacing sedentary activities with more intense and active dynamic physical activities whenever possible. This way, children will have the opportunity to improve their motor proficiency, and, consequently, increase their level of CRF.

On the other hand, as expected, children classified in the low level of CRF presented higher values of body weight and adiposity, in addition to worse performances in the tests of CRF and GMC. In short, it presents a signal of alert for exposure to harmful conditions to the health of children with low CRF and a tendency of stability through the lifespan. It is essential to guide parents and health education professionals to provide experiences of learning through sports in an appropriate development environment for children that also guide the promotion of a healthy weight during infancy.

The evidence can bring practical implications in the school context, in which evaluating CRF inside schools doesn't only get a momentary evaluation, as it can be done the monitoring of an essential variable of health, as well as indicate a predisposition about other physical-motor variables.

COMPLIANCE WITH ETHICAL STANDARDS

Funding

This research received no specific grants from funding agencies in the public, commercial, or not-for-profit sectors. The authors funded this study.

Ethical approval

Ethical approval was obtained from the local Human Research Ethics Committee – Universidade Tecnológica Federal do Paraná and the protocol (no. 3.365.489) was written in accordance with the standards set by the Declaration of Helsinki.

Conflict of interest statement

The authors have no conflict of interests to declare.

Author Contributions

Conceived and designed the experiments: ÉMN, RNC, MCSR; Performed the experiments: ÉMN, RNC, CRRA; Analyzed the data: ÉMN, RNC, CRRA, MCSR; Contributed with reagents/materials/analysis tools: ÉMN, RNC, CRRA, MCSR; Wrote the paper: ÉMN, RNC, CRRA, MCSR.

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