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Low aerobic fitness among adolescents: prevalence and associated factors

Leandro Lima Borges[1], Diego Augusto Santos Silva[1]*, Andressa Ferreira da Silva[1], Gustavo de Carlos Felicio dos Santos Barbosa[1], Matheus Silveira Pedroso Matheus[1], Eduarda Valim Pereira[2], Joni Márcio de Farias[2]

ABSTRACT

It was our objective to estimate the prevalence and associated factors with low aerobic fitness among adolescents. A cross-sectional study was conducted with 575 subjects aged 11–17 years from Criciúma, SC, Brazil. The 9-minute walk/run test was used to assess aerobic fitness. Sociodemographic data and daily habits were collected using a self-administered questionnaire. Anthropometric evaluation was also performed to calculate anthropometric indicators of obesity. The Chi-square test and the binary logistic regression were used. The prevalence of low aerobic fitness in boys aged 11–13 years was 46.0% and in girls 40.5% (p< 0.05), while in boys aged 14–17 years, the prevalence was 59.6% and in girls 46.6 % (p<0.05). Boys aged 11-13 (OR: 5.04; 95%CI 1.93–13.17) and those aged 14–17 years (OR:3.78; 95%CI 1.90–7.52) and girls aged 11-13 years (OR: 3.62; 95%CI 1.24–10.52) from private schools were about four times more likely of having low aerobic fitness compared to those from public schools. Girls aged 11–13 years (OR: 2.40; 95%CI 1.04–5.54) with inadequate sleep were more likely to have low aerobic fitness than those with adequate sleep. High prevalence of low aerobic fitness was associated with private schools and inadequate sleep in both sexes.

KEYWORDS: cardiorespiratory fitness; students; adolescent health; running.

INTRODUCTION

Cardiorespiratory fitness is considered an important health marker in adolescents (Silva et al., 2020), as it determines the capacity of the circulatory and respiratory system to provide energy during prolonged physical activity and eliminate fatigue products after energy supply (Garber et al., 2011). Low aerobic fitness is considered when values are below the levels considered adequate for good health (Gonçalves, Junior, Nunes, Souza, & Silva, 2018). A systematic review study carried out between 2005 and 2017, with individuals aged 6-19 years from different Brazilian regions, identified that the prevalence of children and adolescents who meet the health criteria for cardiorespiratory fitness varied between 7.5% and 70.4%, and this variation was higher in girls than in boys (Gonçalves, Junior, Nunes, Souza, & Silva, 2018). However, a recent study carried out in Southern Brazil showed low aerobic fitness above 80% among adolescents of both sexes (Mello, Mello, Vian, Gaya, & Gaya, 2019). Low aerobic fitness can be associated with biological aspects such as sex and age, in which females have lower VO_2max values compared to males (Gonçalves & Silva, 2016), and older adolescents have lower levels of aerobic fitness than younger adolescents (Mello, Ribeiro, Castagna, Bergmann, & Bergmann, 2013).

Some factors may directly impact the decrease in levels of aerobic fitness, such as sociodemographic indicators, lifestyle, and anthropometric indicators. For example, a study showed that adolescents of lower socioeconomic status had lower levels of aerobic fitness than adolescents of higher socioeconomic status (Vasques, Silva, & Lopes, 2007). Studies do not report an association between aerobic fitness and type of

[1]Universidade Federal de Santa Catarina – Florianópolis (SC), Brazil.
[2]Universidade do Extremo Sul Catarinense – Criciúma (SC), Brazil.
*Corresponding author: Universidade Federal de Santa Catarina, Centro de Desportos, Departamento de Educação Física, Trindade – CEP: 88040-900 – Florianópolis (SC), Brazil. E-mail: diegoaugustoss@yahoo.com.br

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school (private and public); however, the relationship between socioeconomic level and type of school may suggest that students from public schools are also associated with greater odds of having low aerobic fitness (Alves & Soares, 2009; Oliveira, Silva, Maggi, Petroski, & Farias 2012).

As for lifestyle habits, which are modifiable factors, physically inactive girls showed lower aerobic fitness than physically active girls, but for boys, this association is not significant (Oliveira, Silva, Maggi, Petroski, & Farias 2012). On the other hand, boys with inadequate eating habits are more likely to have low aerobic fitness than boys with an adequate diet (Silva, Tremblay, Pelegrini, Silva, & Petroski, 2015). In addition, poor sleep quality is associated with low aerobic fitness, reaching a prevalence of 88.6% of the population with poor sleep quality (De Lima & Silva, 2018).

As for anthropometric indicators, studies with adolescents aged 10-17 years showed that 92% of those with excess weight, defined by body mass index (BMI), demonstrated low aerobic fitness, while in those with normal weight, 68.1% had low aerobic fitness (Mello, Ribeiro, Castagna, Bergmann, & Bergmann, 2013; Gonçalves & Silva, 2016). For the waist-to-height ratio (WtHR), height and waist circumference (WC), and conicity index (C Index), the increase in these values negatively influence VO_2max for both boys and girls, with the exception of the C Index for girls (Gonçalves, 2019).

Considering that for every 10 Brazilian adolescents, seven have low aerobic fitness (Gonçalves, Junior, Nunes, Souza, & Silva, 2018), it is important to monitor this health indicator among adolescents. In addition, the knowledge of factors associated with low aerobic fitness can be the first step towards interventions at the school level in order to propose preventive and effective actions, as monitoring aerobic fitness during adolescence serves as a way to predict future health risks (Gonçalves et al., 2018). Thus, the present study aimed to estimate the prevalence and associated factors (economic level, school type, eating habits, sleep, physical activity, and anthropometric indicators) with low aerobic fitness among adolescents. Based on the aforementioned authors, the hypothesis of this study is that adolescents aged 11–17 of both sexes, of low economic status, from public schools, physically inactive, with inadequate eating habits and anthropometric indicators (BMI, WtHR, WC, and Index C) above standard values are more likely of having lower aerobic fitness compared to their peers.

METHOD

This is a cross-sectional epidemiological study, which is part of the "Association between health status, risk behaviors and level of physical activity of students from public schools in the city of Criciúma — SC", research approved by the Ethics Committee on Human Research at "Extremo Sul Catarinense" University on June 26th, 2015 under protocol No. 1.125.725. To participate in the research, adolescents signed the Assent Term (TA), and parents/guardians signed the Free and Informed Consent Form (TCLE).

The research was carried out in the city of Criciúma, Santa Catarina, Brazil. The municipality has a Human Development Index of 0.788 and a life expectancy of 75.8 years (Atlas Brasil, 2016). It was carried out with students enrolled from the 5th year of elementary school to the 3rd year of high school from municipal, state, and private schools, making up the study population of 17,000 students.

Population and Sample

The sample size of the macro project was calculated considering overweight, low levels of physical activity, and low levels of aerobic fitness as main outcomes. The estimated prevalence was 30% for overweight or 70% for low levels of physical activity, and low levels of aerobic fitness, based on previous studies carried out in the same city (Oliveira, Silva, Maggi, Petroski & Farias 2012; Silva, Teixeira, de Oliveira & Petroski, 2016). A confidence level of 95% was adopted, with a 5% estimated error, design effect of 1.5, and an increment of 20% for losses and refusals. Thus, the estimated sample was 583 adolescents.

For the representativeness of the selected sample, the type of school (municipal, state, and private) and school grade were considered. Two stages were carried out for sample selection: the first stage considered the school, and the second stage considered the classes. The stratification criterion selected was the type of school in which schools with the largest number of grades were selected for the first stage. From the first stage, the second stage selected schools considering the density of classes per school. All students in selected classes were invited to participate in the study.

Evaluators participated in training programs to standardize data collection procedures. Data collection took place in the 2nd semester of 2015; questionnaires were applied in the classroom, and physical tests and anthropometric measurements were performed in the school gymnasium. Students aged 11–17 years who had no health problems participated in aerobic fitness tests and anthropometric measurements. Students who refused to participate in the research were considered refusals, and those who did not deliver the Free and Informed Consent Form signed by parents/guardians did not perform evaluations. Figure 1 shows the sampling process of the present study.

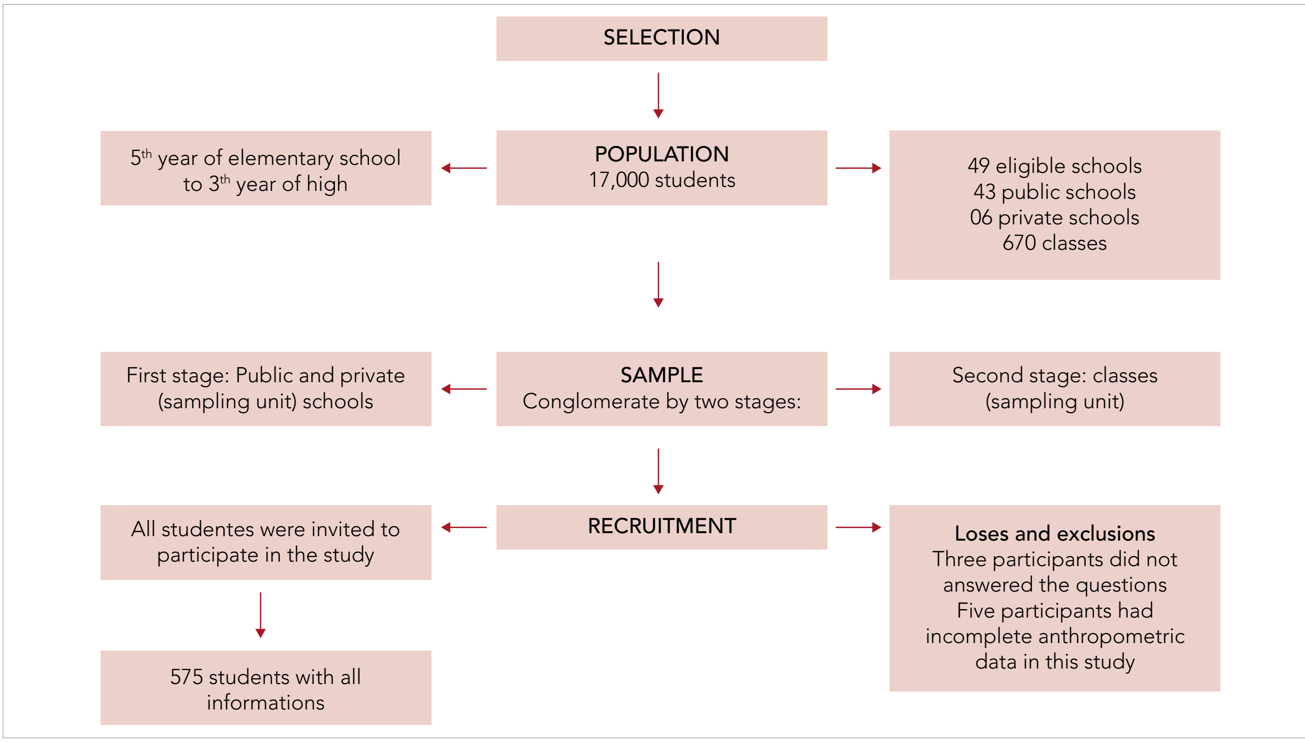

Figure 1. Fluxogram of sample process in this study.

Dependent variable

Aerobic fitness was assessed by the 9-minute walk/run test of the American Alliance for Health Physical Education Recreation and Dance (AAHPERD, 1980), validated for children and adolescents (Turley et al., 1994; Paludo, Batista, Júnior, Cyrino, & Ronque, 2012). The test consists of running the longest distance in nine minutes, being allowed to walk and/or run; however, adolescents were encouraged to run all the time. The test was carried out on tracks organized in the schools' sports courts (Mello, Ribeiro, Castagna, Bergmann, & Bergmann, 2013). The distance covered was measured in meters and categorized by levels of aerobic fitness as "low" and "high", according to cutoff points for age and gender developed for the Brazilian population; for boys aged 6–17 years, the cutoff point was between 1,190 and 1,520 meters, and for girls, the cutoff point was between 1,070 and 1,200 meters (Silva et al., 2020).

Independent variables

A self-administered questionnaire was used to collect sociodemographic indicators (economic level and type of school) and lifestyle (physical activity, eating habits, and sleep quality). The consistency of measurements of this instrument was tested in a previous study (Silva et al., 2013) and presented agreement close to 0.99. The economic level was assessed by the Brazilian Association of Research Companies questionnaire (ABEP, 2017). Responses were categorized as "High" purchasing power (A1, B1, and B2) and "Low" purchasing power (C1, C2, D, and E). The type of school was categorized as "public" and "private". In addition, anthropometric measures of body mass (BM), height, and waist circumference (WC) were measured, as recommended in the literature (Stewart, Marfell-Jones, Olds, & Ridder, 2011), and anthropometric BMI, WtHR, and C index indicators were also calculated.

Physical activity was assessed using one question from the Youth Risk Behavior Surveillance System (YRBSS) questionnaire, translated and validated for Brazil (Guedes & Lopes, 2010), regarding moderate to vigorous physical activity for at least 60 minutes. Responses were categorized as "physically active" when active for 7 days and "not physically active" when active less than 7 days a week. This classification was established according to literature (WHO, 2010).

Eating habits were assessed using the following question from the Fantastic Lifestyle questionnaire (Wilson, Nielsen & Ciliska, 1984), translated and validated for the Brazilian population (Rodriguez Añez, Reis & Petroski, 2008): "Do you eat a balanced diet?" Response options were: "almost never", "rarely", "sometimes", "relatively often", "almost always". Diet was categorized as "adequate" (options "relatively often" and "almost always") and "inadequate" (other options). In this question, students received an explanation of what would be considered an adequate diet, according to recommendations established by the measurement instrument.

Sleep quality was assessed using the following question from the Fantastic Lifestyle questionnaire (Rodriguez Añez et al., 2008): "Do you sleep well and feel rested?" Response options were: "almost never", "rarely", "sometimes", "relatively often", "almost always". Sleep quality was categorized as "adequate" (options "relatively often" and "almost always") and "inadequate" (other options), according to a study that evaluated the same variable (De Lima & Silva, 2018).

BM and height were used to calculate BMI. BM was measured using G-tech® digital scale (Zhongshan, China), in kilograms (kg), with a resolution of 0.1 kilograms (kg). Height was measured using Sanny® stadiometer (São Paulo, Brazil), with resolution in millimeters (mm). Cutoff points were used by age group from 11 to 17 years and gender, according to WHO (2016), in which Z scores were estimated. BMI was categorized as "normal" (Z score< +1 standard deviation) and "high" (Z score≥ +1 standard deviation) (WHO, 2016).

WC was measured using anthropometric Sanny® tape (São Paulo, Brazil), with resolution in millimeters (mm). With WC and height values, WtHR was calculated using the following formula: WtHR= WC (cm)/ height (cm). This variable was categorized utilizing a single cutoff point of 0.5, in which subjects with values equal to or above this value were classified as with high WtHR (Mccarthy & Ashwell, 2006).

C index was calculated using the following formula: C index= WC (m)/ 0.109 x (√ BM (kg)/ height (m)). This variable was categorized according to cutoff points for gender and age developed for the Brazilian population (De Oliveira & Guedes, 2018). Girls and boys aged 12–15 years with C index < 1.13 and < 1.16, respectively, were categorized as "normal", above these values, they were categorized as "high" (De Oliveira & Guedes, 2018). Girls and boys aged 16–17 years with C index < 1.16 and < 1.20, respectively, were categorized as "normal" and above as "high" (De Oliveira & Guedes, 2018). The age of 11 years has no categorization for the age group; therefore, this age was included in the cutoff point of 12-15 years (de Oliveira & Guedes, 2018).

WC was used to classify adolescents with abdominal obesity. This variable was categorized according to cutoff points established for sex and age developed for the Brazilian population (De Oliveira & Guedes, 2018). Girls and boys aged 12–15 years with WC< 75.8 cm and < 77.2 cm, respectively, were categorized as "normal" and above these values, they were categorized as "high". Girls and boys aged 16–17 years with WC< 78.1 cm and <83.3 cm, respectively, were categorized as "normal" and above as "high" (De Oliveira & Guedes, 2018). The age of 11 years has no categorization for this age group, so it was included in the cutoff of 12-15 years (de Oliveira & Guedes, 2018).

Statistical analysis

Descriptive statistics (mean, median, standard deviation, and frequencies) were used to characterize variables, followed by Student's T-test for independent samples to verify differences between genders. To verify data normality, the Shapiro-Wilk was used. However, only height for boys showed normal distribution. In this sense, Mann Whitney's nonparametric test was performed for the other variables. The effect size (Cohen'D) was performed in the comparison between sexes, with values below 0.2 being classified as low, 0.5 as medium, and 0.8 as large effect size (Cohen, 1988).

The Chi-square test was used to verify the association between aerobic fitness and associated factors. Subsequently, crude and binary adjusted logistic regression analysis were used to analyze associations between outcome (aerobic fitness) and independent variables (physical activity, type of school, economic level, eating habits, sleep quality, and anthropometric indicators of obesity: BMI, WtHR, WC and C index), estimating odds ratio (OR) and 95% confidence interval (95%CI).

For the adjusted logistic regression, all independent variables were introduced at the same time into the model, regardless of the p-value of the crude analysis, and variables with a p≤ 0.20 remained, according to the backward method. Variables sex (male/female) and age (11–13 years, and 14–17 years) were used to stratify the sample. Analyses were performed using the Statistical Package for the Social Sciences software (SPSS Statistics, Chicago, United States version 17.0).

RESULTS

A total of 575 adolescents aged 11–17 years participated in this study. Most adolescents were girls (51.3%). A significant difference was observed between sexes for the 9-minute walk/run, in which boys had a higher distance covered value in the test. The effect size was considered low for all variables when comparing sexes. The other variables did not differ, according to sex (Table 1).

Boys aged 14–17 years had a higher prevalence of low aerobic fitness (59.6%) when compared to girls at the same age. Boys and girls aged 11–13 years did not differ in relation to the prevalence of low aerobic fitness (Table 2).

Among boys aged 11–13 years, 46.0% had low aerobic fitness, and in the age group 14–17 years, 59.6% had low

Table 1. Mean and standard deviation values of the continuous variables of the sample from Criciúma, Santa Catarina, Brazil.

Variables	Boys n (%)	Median	Girls n (%)	Median	p	Cohen'D
Total (n= 575)	280 (48.7)		295 (51.3)			
	Mean (SD)		Mean (SD)			
9 minutes run (m)	1.460.05 (613.94)	1,404.00	1.266.71 (573.08)	1,250.00	< 0.01*	0.00
Age (years)	13.89 (2.08)	14.00	14.02 (2.09)	14.00	0.46	0.06
BM (Kg)	55.70 (13.67)	55.50	56.43 (14.90)	55.00	0.54	0.05
Height (cm)	159.61 (11.16)	160.00	161.19 (11.44)	162.00	0.09	0.14
BMI (kg/m²)	21.64 (3.79)	20.88	21.45 (4.09)	20.57	0.55	0.05
WtHR	0.47 (0.06)	0.45	0.47 (0.06)	0.45	0.85	0.00
WC (cm)	74.65 (9.94)	73.00	75.32 (11.38)	73.00	0.45	0.06
C Index	1.17 (0.09)	1.18	1.18 (0.09)	1.18	0.28	0.11

* p< 0.05; n: sample number; %: percentage; Student's T test for independent sample; Mann Whitney's nonparametric test; SD: Standard Deviation; BM: Body Mass; BMI: Body Mass Index; WtHR: Waist-to-Height Ratio; WC: Waist Circumference; C Index: Conicity Index; Effect-size calculate: Cohen'D.

Table 2. Association between with aerobic fitness and sex according to age group of adolescents from Criciúma, Santa Catarina, Brazil.

Age group	Low aerobic fitness n (%)	p	Low aerobic fitness n (%)	p
	11–13 years		14–17 years	
Total	106 (43.3)		174 (52.7)	
Sex		0.39		0.02*
Boys	57 (46.0)		93 (59.6)	
Girls	49 (40.5)		81 (46.6)	

* p< 0.05; n: sample number; %: percentage; Chi-squared test of heterogeneity.

aerobic fitness. Boys aged 11–13 years and 14–17 years from private schools had a higher prevalence of low aerobic fitness (p-value< 0.01) when compared to those from public schools. Boys aged 11–13 years with inadequate diet had a higher prevalence of low aerobic fitness when compared to those at the same age with adequate diet (Table 3).

For girls aged 11–13 and 14–17 years, 40.5% and 46.6% had low aerobic fitness, respectively. Girls aged 11–13 years from private schools and with inadequate sleep quality had a higher prevalence of low aerobic fitness when compared to those from public schools and with adequate sleep quality (Table 4).

In the crude analysis, boys aged 11–13 years with inadequate diet were more likely to have low aerobic fitness when compared to those with adequate diet; however, this result was not maintained in the adjusted analysis. Boys aged 11–13 years from private schools, both in the crude analysis (OR: 5.39; 95%CI 2.09–13.89) and in the adjusted analysis (OR: 5.04; 95%CI 1, 93–13.17), were more likely of having low aerobic fitness when compared to boys from public schools. In addition, boys aged 14–17 years from private schools, regarding the crude analysis (OR: 3.78; 95%CI 1.90–7.52) and the adjusted analysis (OR: 3.78; 95%CI 1.90–7.52) were more likely of having low levels of aerobic fitness. Finally, for boys aged 11–13 and 14–17 years, no association between the other study variables and low levels of aerobic fitness was found (Table 5).

Both in the crude and adjusted analysis, girls aged 11–13 years from private schools were more likely of having low levels of aerobic fitness (Crude analysis — OR: 3.97; 95%CI 1.39–11.34; Adjusted analysis — OR: 3.62; 95%CI 1.24–10.52) when compared to those from public schools. In both analyses, girls aged 11-13 years with inadequate sleep were more likely of having low levels of aerobic fitness (Crude analysis — OR: 2.61; 95%CI 1.15–5.91; Adjusted analysis — OR: 2.40; 95%CI 1.04–5.54), when compared to those with adequate sleep. In both crude and adjusted analysis, no association between study variables and low levels of aerobic fitness for girls aged 14–17 years was found (Table 6).

Table 3. Association between aerobic fitness and sociodemographic indicators, lifestyle and anthropometric measures among boys from Criciúma, Santa Catarina, Brazil.

Variables	Male					
	Aerobic fitness 11–13 years (n= 124)			Aerobic fitness 14–17 years (n= 156)		
	Low n (%)	High n (%)	p-value	Low n (%)	High n (%)	p-value
Total	57 (46.0)	67 (54.0)		93 (59.6)	63 (40.4)	
Economic level			0.94			0.49
High	31 (46.3)	36 (53.7)		42 (56.8)	32 (43.2)	
Low	26 (45.6)	31 (54.4)		51 (62.2)	31 (37.8)	
School type			<0.01			< 0.01
Public	35 (36.8)	60 (63.2)		37 (45.1)	45 (54.9)	
Private	22 (75.9)	07 (24.1)		56 (75.7)	18 (24.3)	
Physical activity			0.55			0.95
Physically active	52 (44.8)	64 (55.2)		90 (60.0)	60 (40.0)	
Not physically active	05 (62.5)	03 (37.5)		03 (50.0)	03 (50.0)	
Eating habits			0.02			0.40
Adequate	42 (41.2)	60 (58.8)		80 (58.4)	57 (41.6)	
Inadequate	15 (68.2)	07 (31.8)		13 (68.4)	06 (31.6)	
Sleep quality			0.50			0.45
Adequate	18 (41.9)	25 (58.1)		47 (62.7)	28 (37.3)	
Inadequate	39 (48.1)	42 (51.9)		46 (56.8)	35 (43.2)	
BMI			0.93			0.90
Normal	20 (46.5)	23 (53.5)		76 (59.8)	51 (40.2)	
High	37 (45.7)	44 (54.3)		17 (58.6)	12 (41.4)	
WtHR			0.88			0.66
Normal	41 (45.6)	49 (54.4)		75 (60.5)	49 (39.5)	
High	16 (47.1)	18 (52.9)		18 (56.3)	14 (43.8)	
WC			0.91			0.47
Normal	38 (46.3)	44 (53.7)		74 (61.2)	47 (38.8)	
High	19 (45.2)	23 (54.8)		19 (54.3)	16 (45.7)	
C Index			0.50			0.57
Normal	22 (50.0)	22 (50.0)		53 (61.6)	33 (38.4)	
High	35 (43.8)	45 (56.3)		40 (57.1)	30 (42.9)	

n: sample number; %: percentage; Chi-squared test of heterogeneity; BMI: Body Mass Index; WtHR: Waist-to-Height Ratio; WC: Waist Circumference; C Index: Conicity Index.

DISCUSSION

Low levels of aerobic fitness were prevalent in two out of five boys aged 11–13 years and increased to three out of five boys aged 14–17 years. Thus, in the present study, 44.8% of physically active boys aged 11–13 years are found to have low levels of aerobic fitness, while in the age group of 14–17 years, 60% of physically active boys are found to have low levels of aerobic fitness. The decline in age-related aerobic fitness can be explained since there is an increase in body mass characteristic of this age, requiring more oxygen to perform physical activities (Araújo & Oliveira, 2008). In addition, relative VO_2max is inversely proportional to the increase in muscle mass in males (Machado, Guglielmo & Denadai, 2002). Finally, the considerable decline in participation in physical activities as age increases is one of the possible justifications for the low levels of aerobic fitness among older adolescents (Malina, 2001).

Table 4. Association between aerobic fitness and sociodemographic indicators, lifestyle and anthropometric measures among girls from Criciúma, Santa Catarina, Brazil.

Variables	Female					
	Aerobic fitness 11–13 years (n= 121)			Aerobic fitness 14–17 years (n= 174)		
	Low n (%)	High n (%)	p-value	Low n (%)	High n (%)	p-value
Total	49 (40.5)	72 (59.5)		81 (46.6)	93 (53.4)	
Economic level			0.85			0.32
High	25 (39.7)	38 (60.3)		47 (50.0)	47 (50.0)	
Low	24 (41.4)	34 (58.6)		34 (42.5)	46 (57.5)	
School type			< 0.01			0.57
Public	36 (35.3)	66 (64.7)		33 (49.3)	34 (50.7)	
Private	13 (68.4)	06 (31.6)		48 (44.9)	59 (55.1)	
Physical activity			0.73			0.11
Physically active	47 (39.8)	71 (60.2)		80 (48.2)	86 (51.8)	
Not physically active	02 (66.7)	01 (33.3)		01 (12.5)	07 (87.5)	
Eating habits			0.09			0.70
Adequate	38 (37.3)	64 (62.7)		68 (47.2)	76 (52.8)	
Inadequate	11 (57.9)	08 (42.1)		13 (43.3)	17 (56.7)	
Sleep quality			0.02			0.56
Adequate	11 (26.2)	31 (73.8)		41 (48.8)	43 (51.2)	
Inadequate	38 (48.1)	41 (51.9)		40 (44.4)	50 (55.6)	
BMI			0.85			0.25
Normal	25 (39.7)	38 (60.3)		72 (48.3)	77 (51.7)	
High	24 (41.4)	34 (58.6)		09 (36.0)	16 (64.0)	
WtHR			0.85			0.60
Normal	36 (40.0)	54 (60.0)		67 (47.5)	74 (52.5)	
High	13 (41.9)	18 (58.1)		14 (42.4)	19 (57.6)	
WC			0.74			0.27
Normal	26 (41.9)	36 (58.1)		57 (49.6)	58 (50.4)	
High	23 (39.0)	36 (61.0)		24 (40.7)	35 (59.3)	
C Index			0.98			0.30
Normal	11 (40.7)	16 (59.3)		35 (51.5)	33 (48.5)	
High	38 (40.4)	56 (59.6)		46 (43.4)	60 (56.6)	

n: sample number; %: percentage; Chi-squared test of heterogeneity; BMI: Body Mass Index; WtHR: Waist-to-Height Ratio; WC: Waist Circumference; C Index: Conicity Index.

Among girls aged 11–13 years, 40.5% had low levels of aerobic fitness, while in the age group 14–17 years, this value increased to 46.6%. A study carried out in Cascavel (PR), Brazil, with 1223 girls aged 10–17 years, identified low levels of aerobic fitness in half of the sample (Minatto et al., 2016). When stratifying by age group, the aforementioned study had a higher prevalence of low levels of aerobic fitness at older ages, with girls aged 10–12 years having VO_2max value of 42.4 $L \cdot min^{-1}$, and in girls aged 13–15 years, VO_2max decreased to 37.2 $L \cdot min^{-1}$ and, finally, in girls aged 16–17 years, VO_2max decreased even more, to 32.8 $L \cdot min^{-1}$ (Minatto et al., 2016). After menarche, girls tend to have a sharp increase in body fat percentage and body changes, such as increases in breasts and hips, which can cause disadvantages in motor performance (Luguetti, Ré & Böhme, 2010). In addition, other factors may be associated with low levels of aerobic fitness in women, such

Table 5. Crude and adjusted logistic regression between aerobic fitness and associated factors among boys from Criciúma, Santa Catarina, Brazil.

Variables	Male (n= 280)							
	11–13 years				14–17 years			
	OR	Crude analysis (95%CI)	OR	Adjusted analysis* (95%CI)	OR	Crude analysis (95%CI)	OR	Adjusted analysis* (95%CI)
Economic level								
High	1		1		1		1	
Low	0.97	(0.48–1.98)	1.02	(0.46–2.26)	1.25	(0.66–2.38)	1.30	(0.66–2.55)
School Type								
Public	1		1		1		1	
Private	5.39	(2.09–13.89)‡	5.04	(1.93–13.17)‡	3.78	(1.90–7.52)‡	3.78	(1.90–7.52)‡
Physical activity								
Physically active	1		1		1		1	
Not physically active	2.05	(0.47–8.99)	1.80	(0.37–8.79)	0.67	(0.13–3.41)	0.51	(0.09–2.90)
Eating habits								
Adequate	1		1		1		1	
Inadequate	3.06	(1.15–8.16)†	2.69	(0.96–7.55)	1.54	(0.55–4.30)	1.02	(0.32–3.27)
Sleep quality								
Adequate	1		1		1		1	
Inadequate	1.29	(0.61–2.72)	1.09	(0.46–2.54)	0.78	(0.41-–1.49)	0.72	(0.36–1.42)
BMI								
Normal	1		1		1		1	
High	0.97	(0.46–2.03)	0.57	(0.22–1.46)	0.95	(0.42–2.16)	1.22	(0.38–3.96)
WtHR								
Normal	1		1		1		1	
High	1.06	(0.48–2.34)	1.36	(0.39–4.70)	0.84	(0.38–1.84)	1.06	(0.32–3.49)
WC								
Normal	1		1		1		1	
High	0.96	(0.45–2.02)	1.64	(0.71–3.79)	0.75	(0.35–1.61)	0.75	(0.33–1.67)
C Index								
Normal	1		1		1		1	
High	0.78	(0.37–1.63)	0.98	(0.34–2.78)	0.83	(0.44–1.58)	0.95	(0.44–2.06)

* Adjusted Analysis; † p< 0.05; ‡ p< 0.001; OR: Odds ratio; 95%CI: Confidence Interval; BMI: Body Mass Index; WtHR: Waist-to-height ratio; WC: Waist Circumference; C Index: Conicity Index; Final model 11–13 years boys, variables: school type e eating habits; Final model 14–17 years boys, variables: school type; Reference category: High aerobic fitness.

as biological factors, psychosocial and cultural implications, and aerobic performance influencers, such as motivation, low tolerance to activity discomfort, and low adherence to aerobically-orientated physical activity programs (Carvalho Filho, de Lucena Martins & da Silva, 2006).

A higher likelihood of low levels of aerobic fitness was identified in girls aged 11–13 years with poor sleep quality compared to girls with adequate sleep quality. Little sleep time in adolescents is a potential cause of obesity due to increased obesogenic behaviors, such as low levels of physical activity and greater food intake (Fatima, Doi, & Mamun, 2015). Furthermore, the physiological effects of little sleep time on athletic performance interfere in the reduction of motor capacity, reaction time, and changes in glucose levels,

Table 6. Crude and adjusted logistic regression between aerobic fitness and associated factors among girls from Criciúma, Santa Catarina, Brazil.

Variables	Female (n= 295)							
	11–13 years				14–17 years			
	OR	Crude analysis (95%CI)	OR	Adjusted analysis* (95%CI)	OR	Crude analysis (95%CI)	OR	Adjusted analysis* (95%CI)
Economic level								
High	1		1		1		1	
Low	1.07	(0.52–2.22)	1.08	(0.49–2.37)	0.74	(0.41–1.35)	0,78	(0,43–1,45)
School type								
Public	1		1		1		1	
Private	3.97	(1.39–11.34)†	3.62	(1.24–10.52)†	1.19	(0.65–2.20)	1,23	(0,65–2,30)
Physical activity								
Physically active	1		1		1		1	
Not physically active	3.02	(0.27–34.27)	2.85	(0.25–33.13)	0.15	(0.02–1.28)	0,15	(0,02–1,28)
Eating habits								
Adequate	1		1		1		1	
Inadequate	2.32	(0.86–6.26)	1.11	(0.33–3.76)	0.85	(0.39–1.89)	0,92	(0,40–2,12)
Sleep quality								
Adequate	1		1		1		1	
Inadequate	2.61	(1.15–5.91)†	2.40	(1.04–5.54)†	0.84	(0.46–1.52)	0,82	(0,45–1,52)
BMI								
Normal	1		1		1		1	
High	1.07	(0.52–2.22)	1.15	(0.40–3.35)	0.60	(0.25–1.45)	0,59	(0,24–1,43)
WtHR								
Normal	1		1		1		1	
High	1.08	(0.47–2.48)	1.45	(0.59–3.55)	0.81	(0.38–1.75)	1,24	(0,46–3,38)
WC								
Normal	1		1		1		1	
High	0.88	(0.43–1.83)	0.89	(0.33–2.41)	0.70	(0.37–1.32)	0,78	(0,31–1,99)
C Index								
Normal	1		1		1		1	
High	0.99	(0.41–2.36)	1.04	(0.33–3.28)	0.72	(0.39–1.33)	0,80	(0,42–1,50)

* adjusted analysis; † p< 0.05; OR: Odds ratio; 95%CI: Confidence Interval; BMI: Body Mass Index; WtHR: Waist-to-height ratio; WC: Waist Circumference; C Index: Conicity Index; Final model 11–13 years girls, variables: school type e sleeping quality; Final model 14–17 years girls, variables: Physical activity; Reference category: High aerobic fitness.

which negatively influence performance and the psychological effects of short sleep time, where mood alterations, tiredness, and anxiety stand out (Soares, 2012).

Boys in the present study, regardless of age, and girls aged 11–13 years from private schools were more likely to have low levels of aerobic fitness when compared to their pairs from public schools. Students from private schools mostly belong to higher socioeconomic classes compared to public school students (Alves & Soares, 2009), concomitantly, the higher the socioeconomic class, the greater the time spent on sedentary behaviors due to the financial ease in obtaining electronics and use of passive commuting (Oliveira et al., 2012). The longer time in sedentary behaviors results in lower levels of aerobic fitness (Santos et al., 2012). In addition, students from public schools, being of lower socioeconomic classes, tend to practice activities at no financial cost, such as outdoors plays and games and in environments outside the school, and participate more in domestic activities and small manual jobs, which reduce the time spent on sedentary behaviors and increase the time spent on physical activities (Malina, 2001; Oliveira, Silva, Santos, Silva, & Conceição, 2010).

Of the limiting factors of this research was the non-measurement of the maturational status, despite having chronological age as a study variable, it could influence the levels of aerobic fitness because it is the moment when there is a significant increase in the body structures of adolescents, regardless of other variables (Oliveira & Veiga, 2005; Roman, Ribeiro, Guerra-Júnior & Barros-Filho, 2009). In addition, the test used to measure aerobic fitness can also be considered another limitation, as it is a field test in which motivational factors can interfere with performance in the test. In addition, environmental factors can also interfere with physical test performance. Another limitation was the measurement of levels of physical activity through questionnaire, which is less accurate than direct measurement instruments. Diet and sleep issues were measured by recall, which can lead to memory bias. Finally, the present study has a cross-sectional design, which prevents establishing cause and effect relationships.

Among the positive points of the study, the contribution of the subject to literature was highlighted, investigating the possible factors associated with low aerobic fitness among adolescents. In addition, this study presented data on the levels of aerobic fitness of adolescents, serving as a comparison with similar studies conducted in different regions. In addition, from this study, there is a need for further research that stratifies adolescents by age group in order to compare the factors that influence aerobic fitness and different ages. Finally, the present study encourages the creation of programs aimed at improving the health of adolescents in order to reduce future health risks.

CONCLUSIONS

Boys and girls from Criciúma (SC), Brazil, have a high prevalence of low aerobic fitness, and the highest values were identified as the age group increases. Type of school was a significant factor associated with aerobic fitness since students of both sexes from private schools were more likely to have low aerobic fitness. Finally, girls with inadequate sleep had a higher prevalence of low aerobic fitness. From this and future studies, with the same stratification, it will be possible to identify which groups tend to have low aerobic fitness and thus give more focus to build intervention strategies.

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