Original Article

Temporal trends in physical fitness and obesity among Brazilian children and adolescents between 2008 and 2014

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ABSTRACT

The research aims to assess the trend of the health-related physical fitness over a period comprising 2008-2014, in two cohorts of a voluntary Brazilian school aged children and adolescents. Data was obtained from the database of Project Sport Brazil. The sample comprised children and adolescents aged between 10-17 years, assessed in two cohorts: 2008-2009 (6,281) and 2013-2014 (4,052) from different Brazilian regions. Measurement of the health-related physical fitness included: sit-up abdominal test, sit and reach, nine-minute of running/walking test, and body mass index. Descriptive data analyses and Poisson Logistic Regression were used. Prevalence trends of unhealthy flexibility increased significantly for boys from 35.2% to 38.4% and girls 23.5% to 38.0%, while prevalence on unhealthy abdominal strength/resistance decreased significantly for boys from 35.9% to 30.0% and did not show differences over time for girls. Overweight/obesity increased significantly over time in boys from 18.9% to 23.7%, as well as in girls from 19.4% to 28.0%. Cardiorespiratory fitness (CRF) showed the highest variation over time with a significantly increase of the unhealthy zone for both, boys from 33.4% to 61.3% and girls 33.3% to 66.6%. Therefore, we emphasize the importance of implementation national campaigns and interventions promoting physical activity in order to improve health.
Keywords: Physical education; School children; Cardiometabolic health; Musculoskeletal health; Overweight.

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INTRODUCTION

Physical fitness has been considered an important health indicator among adult and paediatric population (Blair et al. 1989; Lee, Artero, Sui, & Blair, 2010; Bouchard, Blair, & Katzmarzyk, 2015). Further, studies reported a strong association between unhealthy levels of physical fitness with morbidity and mortality. (Andersen & Froberg, 2015; Högström, Nordström, & Nordström, 2015).

Among physical fitness health-related components, cardiorespiratory fitness (CRF) and body mass index (BMI) has been considered important and independent indicators for cardiometabolic risk factors in all ages (Barry et al., 2014). Children and adolescents with low levels of CRF and overweight/obesity have shown increased chances for early developing cardiometabolic risk factors (Lee et al., 2010). Likewise, motor and muscle fitness (MF) components such as flexibility, abdominal strength, speed, agility and upper and lower limb strength were suggested as indicators for a skeletal and cardiometabolic healthier profile (García-Artero et al. 2007). Besides, found a relationship between MF components with C-reactive protein, independently of CRF (Ruiz et al., 2008).

MF components have also shown a strong association with osteoporosis, enhanced bone density and low back pain (Kemper et al., 2000). In this context, Vicente-Rodriguez et al., (2008) reported that the bone mineral content of the body was directly associated with physical fitness and seems to be mediated by the association between fitness and lean mass. In addition, two longitudinal studies indicated that the main fitness-health component related to unhealthy skeletal muscles was neuromuscular fitness defined by MF and speed (Kemper et al., 2000; Barnekow-Bergkvist, Hedberg, Pettersson, & Lorentzon, 2006).

Fitness tests provide important diagnostic information about the health status of the individual (Högström et al., 2015). It is popularly believed that today's children are less physically fit than children from the past. Much of the research examining fitness trends in children has focused on children's ability to perform CRF exercise (Tomkinson, Lang, & Tremblay, 2017). While there are relatively fewer studies on temporal trends in children's MF, a systematic analysis of 20.8 million, 6- to 19-year-olds, from 23 countries indicated very small improvements in mean jumping ability of 0.3% per decade between 1958 and 2003 (Tomkinson, 2007) .

Few studies have examined temporal trends in fitness among South American children and youth. One study of 2,826 Brazilian girls aged 9–17 years reported small improvements of 3.0% per decade in mean CRF between 1998 and 2006 (Tomkinson et al., 2017). In contrast, a study of 1,291 children, 10- and 11-year-olds from Ilhabela city, Brazil, reported large declines of 8.6% and 5.7% per decade in the mean CRF of normal weight and overweight children between 1980 and 2010, respectively, with much of the observed decline occurring after 2000 (Moraes-Ferrari, Bracco, Matsudo, & Fisberg, 2013). In a subsequent study developed in the same city, negligible to small declines in mean muscular strength, assessed as handgrip strength and vertical jump, were reported over the same 30-year period (Ferrari, Matsudo, & Fisberg, 2015). Regarding BMI trends, Flores, Gaya, Petersen & Gaya (2013) indicated toward increase in prevalence of obesity occurrence among children and adolescents from Brazil, between 2005 to 2011.

In an attempt to fill these gaps, and considering the evidence that children and adolescents no longer spend their free time in physical activities (Hallal et al., 2012), this study aimed to assess the trend of the health-related physical fitness over a period comprising 2008-2014, in two cohorts of a voluntary Brazilian school aged children and adolescents.

MATERIALS AND METHODS

This study is a part of a major project entitled “Projeto Esporte Brasil” (PROESP-Br). The PROESP-Br is a national surveillance that offer a support tool for physical education teachers to evaluate the body-grown patterns, nutritional status and physical fitness of children and adolescents aged 6-17 from Brazil (Gaya & Gaya, 2016). Physical education teachers after assessing physical fitness should enter data on a national database.

Data of the present sequential cross-sectional investigation comprised two-separated cohorts of school aged children and adolescents of both genders, aged between 10-17 years, selected from PROESP-Br national database of the year’s 2008/2009 - cohort 1 (6,281 boys and girls) and 2013/2014 - cohort 2 (4,052 boys and girls). Both cohorts included 10,333 children and adolescents who presented complete data of health-related physical fitness. The project was approved by the Ethics Committee of Federal University of Rio Grande do Sul, under number 2.008.010.

Physical education teachers of each institution that joined in the project were responsible for evaluating their own data. PROESP-Br's guidelines were available on website for orientation about the test’s applications (Gaya & Gaya, 2016), and also for additional necessary explanation they could contact PROESP-Br researchers by email or telephone.

The health-related guidelines of physical fitness tests include: (1) musculoskeletal health indicators tests: sit-up at one-minute test (abdominal strength/resistance) and sit and reach (flexibility); (2) Cardiometabolic health indicators tests: running/walking nine-minute tests (CRF) and anthropometric measurement (body mass index - BMI). For all physical fitness measurements, a PROESP-Br cut-off was considered (Gaya & Gaya, 2016).

Musculoskeletal health indicators tests
Abdominal strength was measured by a sit up test, with the students in a supine position with knee flexed at 45° and the arms crossed over the chest. The evaluator holds the student's ankles fixing them to the ground. The student starts with a movements of trunk flexion with elbows near thighs, and after returning to the starting position. The total number of correctly movement done and completed within one minute was considerate.

Sit-and-reach test measures the flexibility of the lower back and hamstring muscles in a sitting position. The test involves sitting on the floor with legs out straight ahead and then reaching as far forward possible. Farthest position that student can reach with the fingertips, in centimetres with one digit after the decimal point was a final result registered. The better of two attempts was recorded.

Cardiometabolic health indicators tests
Nine-minute run/walk test was used to evaluate CRF. Children and adolescents were encouraged to run or walk the greatest distance over the 9-minute period. Children and adolescents were informed at the 3, 6 and 8 minutes and also informed to stop when 9 minutes over. The distance number of laps around the track adding an extra distance in meters with the one digit after the decimal point was measured by researcher and recorded.

For weight measurement was recommended a portable balance with precision of up to 0.5 kg. The school aged children and adolescents should be barefoot and with wear light clothes and remains standing with their elbows straight. The measures must be recorded in kilograms, with one digit after the decimal point. Guidelines for height measurement included use of a stadiometer tape or a tape measure with precision up to 2 mm. Concerning the use of the tape; it is recommended that be fixed on the wall, one meter above the ground. In this case, the evaluator must add 1 meter to the result measured by tape. The height measurement is read with a square-shaped device and expressed in centimetres with one digit after the decimal point. Based on the referred measurements, BMI was calculated as the weight in kilograms divided by the square of the height in meters.

Statistical Analysis

IBM SPPS Statistics V.20.0 for Windows (SPPS, Chicago, Illions, USA) was used for data processing. Boys and girls were analysed separately. Prevalence of unhealthy physical fitness was obtained by descriptive statistics analyses in percentage. Different models of Binary Regression Analyses, adjusted by age in all models and BMI for CRF and muscles fitness models, were used to analyse trend prevalence of unhealthy physical fitness and obesity. For all analyses, a p value $< .05$ was considered statistically significant.

RESULTS AND DISCUSSION

Table 1 presents the descriptive characteristics of the sample, by gender, age, and Brazilian region.

Table 1. Characteristics of children and adolescents evaluated with the PROESP-Br.

	2008/2009		**2013/2014**	
Gender	n	%	n	%
Boys	3.670	58.4	2.223	55.0
Girls	2.610	41.6	1.821	45.0
Age (years)				
10	814	13.0	353	8.7
11	929	14.8	593	14.7
12	1.023	16.3	566	14.0
13	1.113	17.7	653	16.1
14	1.002	16.0	659	16.3
15	792	12.6	548	13.6
16	497	7.9	424	10.5
17	110	1.8	248	6.1
Region				
Northeast	324	5.2	109	2.7
Midwest	731	11.6	728	18.0
Southeast	2.297	36.6	289	7.1
South	2.928	46.6	2.918	72.2
	ẋ	SD	ẋ	SD
Weight (Kg)	49.1	13.4	52.4	14.0
Height (cm)	156.8	12.2	158.2	11.3
BMI	19.6	3.62	20.6	3.99

CRF (m)	1.509	383.1	1.295	319.3
Flex (cm)	24.4	11.7	21.4	8.36
Abd (rep)	32.3	11.8	32.5	11.2

n: number of subjects; %: percentile of subjects; BMI: body mass index; CRF: cardiorespiratory fitness; Flex: flexibility; Abd: Abdominal strength/resistance; ẋ: mean; SD: standard deviation; rep: repetitions per minute.

Table 2 shows prevalence of musculoskeletal health indicators according to the cohort's 1 and 2. Trend analyses showed higher and significant occurrence of flexibility over cohorts 1 when compared with cohorts 2 for boys (35.2% to 38.4%; OR: 1.34, IC: 1.19-1.51) and girls (23.5% to 38.0%; OR: 2.11, IC: 1.84-2.43).

Occurrence of unhealthy abdominal strength/resistance adjusted by BMI and age was higher in boys (35.9%) compared with girls (25.6%) and abdominal strength/resistance in boys showed a decrease trend for 35.9% to 30.0% (OR: 0.71, IC 0.62-0.80). However, results of abdominal strength/resistance did not showed differences between cohorts 1 and 2 for girls (p = .67).

Table 2. Binary logistic regression to estimate the trend of flexibility and abdominal strength/resistance of children and adolescents.

	Boys				Girls			
	Risk zone to flexibility							
	%	*OR*	CI95%	*p*	*%*	*OR*	CI95%	*p*
08/09	35.2	1	-	-	23.5	1	-	-
13/14	38.4	1.34	1.19-1.51	p < .001	38.0	2.11	1.84-2.43	p < .001
	Risk zone to abdominal strength/resistance							
	%	*OR*	CI95%	*p*	*%*	*OR*	CI95%	*p*
08/09	35.9	1	-	-	25.6	1	-	-
13/14	30.0	0.71	0.62-0.80	p < .001	26.4	0.96	0.83-1.12	.671

OR: Odds ratio; CI95%: confidence interval if 95%; p: significance level; %: occurrence in risk zone.

The results for cardiometabolic health indicators adjusted for BMI and age (Table 3) showed that boy's unhealthy CRF prevalence increased from 33.4% to 61.3% (CI: 3.16, CI: 2.76-3.68) while for girls values increased from 33.3% to 66.6% (OR: 3.64, IC: 3.08-4.29). BMI increased from 18.9% to 23.7% (OR: 1.34, CI: 1.88-1.53) in boys, while in girls increased from 19.4% to 28.8% (OR: 1.54, CI: 1.33-1.78).

Table 3. Binary logistic regression to estimate the trend of cardiorespiratory fitness and body mass index of children and adolescents.

	Boys				Girls			
	Risk zone to cardiorespiratory fitness							
	%	*OR*	CI95%	*p*	*%*	*OR*	CI95%	*p*
08/09	33.4	1	-	-	33.3	1	-	-
13/14	61.3	3.16	2.72-3.68	.0001	66.6	3.64	3.08-4.29	.0001
	Risk zone to BMI							
	%	*OR*	CI95%	*p*	*%*	*OR*	CI95%	*p*
08/09	18.9	1	-	-	19.4	1	-	-
13/14	23.7	1.34	1.18-1.53	.0001	28.8	1.54	1.33-1.78	.0001

OR: Odds ratio; CI95%: confidence interval if 95%; p: significance level; %: occurrence in risk zone; BMI: Body mass index.

DISCUSSION

The main purpose of this study was to assess the trend of the health-related physical fitness over a period comprising 2008-2014, in two cohorts of a voluntary Brazilian school aged children and adolescents. Findings revealed that a high number of Brazilian students are classified with low levels of physical fitness and mainly for BMI, CRF and flexibility these occurrences showed a significant increase over the years.

Concerns about decline data of physical fitness and with increased number of overweight/obese youngster has been described world-wide (Venckunas, Emeljanovas, Mieziene, & Volbekiene, 2017; Cohen et al. 2011; Dos Santos et al., 2015). Low levels of physical fitness have been associated with decrease in quality of life, increased economic burden (Venckunas et al., 2017), as well as, with early risk for developing cardiometabolic risk factors (Lee et al., 2010). In this context, the literature has shown that the results about trends of physical fitness among youth population are not consistent (Cohen et al., 2011). However, temporal trends estimated from 965,264 children and adolescents from 19 high-income and upper middle-income countries between 1981 and 2014, suggested a substantial decline in CRF (Tomkinson et al., 2017).

BMI seems to be the physical fitness components with more evidences in the literature (Ogden et al., 2016; Zong et al., 2017). However, there are just a few numbers of studies among Brazilian youths. In this context, results of the present study found that approximately 20-30% of both genders were classified as overweight/obese. These results are similar with data from USA and Europe, from which there was identified approximately 30% of overweight/obese youngsters (Ogden et al., 2016). However, our results showed an increased trend of overweight/obese between cohorts 1 and 2 for both boys and girls. In this context, Flores et al., (2013) and Ogden et al., (2016) suggested a stability tendency of overweight/obese children and adolescents in samples from Brazilian and American, respectively. On the other hand, secular trends including Chinese adolescents showed that prevalence of overweight and obese has grown continuously in both sexes (Zong et al., 2017). These finding is in agreement with our study, which also observed increased trend prevalence over the years.

From public heath perspective it is worthy to discuss levels of CRF (Ortega et al., 2007). Several studies have shown an independent association between CRF and cardiovascular and metabolic risk factors, among youngsters (Andersen & Froberg, 2015; Ortega et al., 2007; Abbasi, Blasey, & Reaven, 2013; Gaya et al., 2009). Our data suggested alarming results because low levels of CRF doubled from 30% to 60% over time in both boys and girls. Beyond other factors, an important issue that should be addressed lies on the very low levels of daily and/or regular physical activity. Hallal et al., (2012) reported that approximately 57% of Brazilian adolescents are inactive. Thus, low levels of physical fitness may be explained also by the little time spent in moderate and vigorous activities during leisure time and/or organized activities such as physical education classes at school (Dumith, 2009). Further, results of our study showed that levels of Brazilian CRF are consistent with reports from other countries (Venckunas et al., 2017; Dos Santos et al., 2015), suggest a global tendency.

Moreover, flexibility is also considering as an important component of physical fitness for health, associated with daily activities and with health indicators (Dorneles, Oliveira, Bergmann, & Bergmann, 2015). However, there is a data lack about trends of flexibility fitness among school aged children and adolescents. The present study pointed-out that approximately 30% of Brazilian school children and adolescents showed low levels of flexibility, and these values increased when compared cohorts 1 and 2 for both boys and girls. To our knowledge this is the first trends flexibility data about representative Brazilian school aged children and adolescents. In the same context (Venckunas et al., 2017), recently, found similar results, indicating decline in flexibility and physical fitness in Lithuanian schoolchildren between 1992 and 2012. While Dos Santos et al., (2015) did not found differences over the years among Mozambican youth boys.

Additionally, MF is also associated with a poor metabolic profile during children and adolescents (Vicente-Rodríguez et al., 2008; Ortega et al., 2007; Dorneles et al., 2015). Among several indicators of muscular strength, the abdominal test is one. Strength/ resistance abdominal in our data did not show a consistent result when compared cohorts 1 and 2. These results are in accordance with several other researches that showed divergent findings about MF in youth (Venckunas et al., 2017; Cohen et al., 2011). In our data, while girls showed a stable prevalence of 25.6% of unhealthy abdominal strength/resistance, boys had a decrease of approximately 5% over time. These data should be associated with growth and maturation process youth, and when compared with other studies with the same population it is possible to observe different results youth (Venckunas et al., 2017; Cohen et al., 2011). However, the present results confirm the findings from another study in Brazilian children aged 10-11 years old, which showed negligible to small declines in mean muscular strength (handgrip strength and vertical jump) (Ferrari et al., 2015).

Physical activity is a key aspect in health promotion among youngsters (Andersen & Froberg, 2015). Consistently, our findings revealed that a great number of youths do not enjoy the benefits of this practice. Our data highlighted that more than half of Brazilian youngsters showed low levels of physical fitness and were considered overweight/obese. Results that might suggest a premature risk for cardiometabolic and musculoskeletal issues and probably the existence of a public health problem.

In addition, it seems to be a consensus that CRF, BMI, flexibility and abdominal strength/resistance are important health indicators that can be modified by regular exercises (Oliveira et al., 2017). Physical education classes and recess time can be a valuable asset for structural physical activity and for improving health aspects among children and adolescents (Escalante, Backx, Saavedra, García-Hermoso, & Dominguez, 2011). However, our findings indicated a worry data about school age children and the necessity of screening for changing the physical inactivity lifestyle among this population.

Finally, the present study has some limitations. Firstly, measurement of physical fitness was based on indirect test. Children and adolescent that comprised the two cohorts are not the same, thus this is a trends study. In addition, we do not have physical activity data that could help explain our results. On the other hand, both cohorts seem to be large and a representative sample of Brazilian school aged children and adolescents. Further, to the best of our knowledge this is the first study that comprised a representative sample of Brazilian youth with measurements of two cohorts over a period of six years.

CONCLUSION

In conclusion, there are a growing number of children and adolescents classified at risk for CRF, flexibility and overweight/obesity increasing between 2008/2009 and 2013/2014. Physical education classes in Brazil should contemplate health promotion in order to change physical activity habits of youngsters and improve physical fitness. Physical activity and sports should always be encouraged, especially in the school environment, in order to promote health-related benefits among Brazilian schoolchildren and adolescents.

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