Body fat, muscular and cardiorespiratory fitness according to sexual maturation among Brazilian adolescents from a town of German colonization

Gordura corporal, aptidão muscular e cardiorrespiratória segundo a maturação sexual em adolescentes brasileiros de uma cidade de colonização germânica

Grasa corporal, aptitud muscular y cardiorrespiratoria según la maturación sexual en adolescentes brasileños de una ciudad de pequeño porte y de colonización Germánica

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ABSTRACT

Objective: To analyze the health-related physical fitness according to stages of sexual maturation in Brazilian adolescents (10 to 17 years-old) living in a small town of German colonization.

Methods: This study was based on a broader project, a school-based cross-sectional epidemiological study conducted with adolescents from public schools (141 males and 129 females) in São Bonifácio, Southern Brazil. The Fitnessgram® battery of tests was applied (body fat percentage, back-saver sit and reach test, curl-up and modified pull-up tests and 20m shuttle run test). Sexual maturation was self-assessed through stages of pubic hair development, being classified from P1 to P5. Results were analyzed by one-way variance analysis, Bonferroni *post hoc* and Kruskal-Wallis tests.

Results: In boys, body fat percentage was 11.4% higher in the P1 stage (p=0.04) and 10.2% higher in the P3 stage (p=0.01), compared to P5. The differences between maturational stages occurred in flexibility (5.1cm increase; p=0.03), curl-up (p=0.04), and pull-up tests (p<0.01) from stages P2 to P5. For girls, the mean VO_{2max} values were lower for those at the final maturation stages (p<0.01).

Conclusions: The differences between stages of sexual maturation were observed in body fat percentage and muscle fitness for males and cardiorespiratory fitness for females. Effective measures to promote physical fitness should be addressed at early maturation stages for boys and for more mature girls.

Key-words: physical fitness; puberty; adolescent health; students; Brazil.

RESUMO

Objetivo: Analisar a aptidão física relacionada à saúde de acordo com os estágios de maturação sexual em adolescentes brasileiros (10 a 17 anos) residentes em cidade de pequeno porte de colonização germânica.

Métodos: Estudo derivado de um projeto populacional de base escolar e delineamento transversal realizado com adolescentes de escolas públicas (140 do sexo masculino e 130 do feminino) de São Bonifácio, Santa Catarina. Aplicaram-se os testes da bateria *Fitnessgram®* (percentual de gordura corporal, teste de senta e alcança, abdominais, flexão de braços em suspensão modificado e vaivém de 20m). A maturação sexual foi autoavaliada por meio dos estágios de desenvolvimento dos pelos pubianos e classificada em P1 a P5. Os resultados foram checados por análise de variância *one-way*, seguida do teste *post hoc* de Bonferroni e o Kruskal-Wallis.

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Resultados: No sexo masculino, observou-se que o percentual de gordura corporal foi 11,4% maior em P1 (p=0,04) e 10,2% maior em P3 (p=0,01), comparado ao P5. As diferenças entre os estágios maturacionais ocorreram na flexibilidade (aumento de 5,1cm – p=0,03), nos testes de abdominais (p=0,04) e na flexão de braços (p<0,01), entre P2 e P5. No sexo feminino, valores médios de aptidão cardiorrespiratória foram inferiores (p<0,01) para aquelas nos estágios finais de maturação.

Conclusões: As diferenças entre os estágios de maturação foram observadas no percentual de gordura corporal e na aptidão muscular para o sexo masculino e na aptidão cardiorrespiratória para o feminino. Ações para melhorar a aptidão física deveriam ser direcionadas aos rapazes nos primeiros estágios de maturação e às moças mais maduras.

Palavras-chave: aptidão física; puberdade; saúde do adolescente; estudantes; Brasil.

RESUMEN

Objetivo: Analizar la aptitud física relacionada a la salud conforme a los estadios de maturación sexual en adolescentes brasileños (10 a 17 años) residentes en ciudades de pequeño porte y de colonización germánica.

Métodos: Estudio derivado de un proyecto de población de base escolar y delineación transversal, realizado con todos los adolescentes de escuelas públicas (141 muchachos y 129 muchachas) de São Bonifácio, Santa Catarina, Brasil. Se aplicaron las pruebas de la batería *Fitnessgram*® (porcentaje de grasa corporal -%GC, prueba de sienta y alcanza, abdominales, flexión de brazos en suspensión modificado y vaivén de 20 metros). La maturación sexual fue autoevaluada mediante los estadios de desarrollo del vello pubiano y clasificada en P1 a P5. Los resultados fueron analizados por ANOVA *one-way*, seguida de la prueba *post hoc* de Bonferroni y el *Kruskal-Wallis*.

Resultados: En los muchachos, se observó que el %GC fue 11,4% superior en P1 (p=0,04) y el 10,2% superior en P3 (p<0,01), comparado al P5. Las diferencias entre los estadios de maturación ocurrieron en la flexibilidad (aumento de 5,1cm - p=0,03), en las pruebas de abdominales (p=0,04) y en la flexión de brazos (p<0,01) entre P2 y P5. En las muchachas, los valores promedios de aptitud cardiorrespiratoria fueron más bajos (p<0,01) para aquellas en los estadios finales de maturación.

Conclusión: Las diferencias entre los estadios de maturación fueron observadas en el %GC y en la aptitud muscular para los muchachos y en la aptitud cardiorrespiratoria para las muchachas. Acciones para mejorar la aptitud física deberían ser dirigidas para los muchachos en las primeras etapas de maturación y para las muchachas más maduras.

Palabras clave: aptitud física; pubertad; salud en el adolescente; estudiantes; Brasil.

Introduction

Sexual maturation, one of the methods used to evaluate biological maturity, is characterized by physical and biological changes that occur during puberty. This period is marked by the development of secondary sexual characteristics, such as genital development in boys and breast in girls and the appearance of pubic hair in both sexes[1]. This phenomenon, related to the biological time and chronological age, not necessarily synchronized, occurs earlier in girls compared to boys[2].

Changes in body structures throughout adolescence correspond to a sharp gain in body fat in girls and muscle mass in boys due to the action of sexual hormones[3,4]. These changes influence physical fitness components such as body composition[5], muscular fitness[6] and cardiorespiratory fitness[6,7]. At this stage, a greater increase in muscle mass is observed in boys, providing greater power/muscular strength[3]. In girls, higher flexibility levels are observed at all ages. Boys tend to have better cardiorespiratory fitness in relation to girls[3].

Chronological age is often used to characterize the physical fitness profile in adolescents[8]; however, biological age (sexual maturation) has emerged as an adjustment variable in the analysis[7,9] due to body changes in puberty. Adolescents of the same chronological age may show different sexual maturation stages, and those who are in more advanced biological maturation stages tend to have physical fitness characteristics different from the others[6,8]. Thus, biological age influences physical fitness components[6], and is therefore relevant to analyze physical fitness according to the pubertal development stages.

Studies available in literature have investigated heterogeneous populations and studies on the physical fitness profile of adolescents with similar socio-cultural characteristics and from the same ethnic origin should be conducted. In this sense, the aim of this study was to analyze the health-related physical fitness profile (body composition, muscular and cardiorespiratory fitness) according to sexual maturation stages in Brazilian adolescents living in a small town of German colonization.

Method

This study on the analysis of health-related physical fitness in adolescents was developed from a cross-sectional epidemiological project called "*Physical activity and lifestyle: a study of three generations in São Bonifácio, Santa Catarina*" approved by the Ethics Committee in Human Research of the Federal University of Santa Catarina (UFSC), process No. 973/10. The study included adolescents (10 to 17 years old) from São Bonifácio, SC, a city in the State of Santa Catarina intentionally selected, in accordance with the criteria adopted: to be a small town of German colonization.

The southern region of Brazil was predominantly colonized by Europeans. The first European colony that settled in Santa Catarina was German, considered to be the second largest ethnic group in the region after the Italians. This state has received immigrants from various countries of Europe, and Germans settled in the northern and southern of Santa Catarina. São Bonifácio stands out for being colonized only by Germans[10].

São Bonifácio is located 70 km from Florianópolis (capital of the State of Santa Catarina), southern Brazil. The first German immigrants came from Westphalia and arrived there in 1864. The population consisted of 3,008 inhabitants with 77% of them living in rural areas. The economy of the city is based on agriculture, with emphasis on tobacco, horticulture, and dairy production[11]. With a Human Development Index of 0.785, São Bonifácio is classified as having intermediate human development index[12].

The target population of the study were adolescents aged 10 to 17 years enrolled in public schools of São Bonifácio in 2010 (n=291). Among the public schools, one is provided by the State and four by the city government. A school census was conducted and all adolescents, aged 10-19 years according to the World Health Organization definition[13], were invited to participate. Inclusion criteria included adolescents aged 10 to 17 years (n=277) that agreed to participate by presenting the consent form signed by their parents or guardians, who were present at school on the day of assessment and able to perform the physical tests. Adolescents who were not present on the days of data collection (n=5), those who did not present the consent form signed by parents or guardians (n=3) and those who refused to participate in the study (n=5) were excluded. In addition, those who did not carry out the sexual maturation self-assessment (n=7) and those who showed any motor limitation for the performance of physical tests on the assessment day (n=1) were also excluded. Therefore, the sample was composed of 270 adolescents (141 boys and 129 girls).

The team of evaluators was composed of 14 teachers and Physical Education students from UFSC. A previous training for the standardization and application of physical tests and anthropometric assessment was conducted and each evaluator was responsible for the application of the same test from beginning to end of data collection.

The data collection period included seven days in September 2010 on school grounds and during the class time. First, in a placeholder, anthropometric measurements (body mass, height and skinfold thickness) were carried out. Then, the adolescents were taken to a multi-sport gymnasium where the physical tests were performed in the following order: back-saver sit and reach, curl-up, modified pull-up and 20-m shuttle run test. Warm-up exercises were not conducted before the tests. Soon after, sexual maturation was self-evaluated, driven by an evaluator of the same sex of the adolescent.

Body mass was measured using a digital scale (*Filizola*®) with a capacity of 150kg and a 100-gram scale. Height was obtained with a stadiometer (*Sanny*®), with a measurement scale of 0.1cm. Triceps (TRSF) and subscapular (SESF) skinfolds were collected using Cescorf® scientific adipometer, a Brazilian model with mechanics and design similar to the Harpenden® English model, with constant pressure for any opening of its rods around 10g/mm^2, measurement unit of 0.1mm and contact area (surface) of 90mm^2. The measurements were performed by two trained evaluators. For this function, prior to data collection, they performed the calculation of the intra and inter-evaluator Technical Error of Measurement (TEM) with a sample of 17 adolescents using the difference method[14,15]. The intra-evaluator TEM limit was 3% for skinfolds and 1% for other measures. For the inter-evaluator TEM, an error limit of 7% for skinfolds and 1% for other measures were adopted. SESF and TRSF were applied by calculating the body fat percentage using the equation of Slaughter *et al*[16].

The health-related physical fitness components investigated were: body composition and cardiorespiratory and muscular fitness. The procedures proposed by the Fitnessgram® were followed for the performance of the tests[17]. For the performance of tests, students should be wearing shorts, shirt and tennis. In anthropometric assessments, boys should be wearing only shorts and girls should be wearing shorts and vest top.

Body fat percentage[16] was used to assess body composition. The muscular fitness was obtained by evaluating flexibility

(back-saver sit and reach test) and power/muscular strength (curl-up and modified pull-up tests). In the back-saver sit and reach test, the greatest distance reached in each leg positioning was considered. Due to the high correlation found between flexibility of the right and left leg (r=0.92), the average of the two measurements was used. In the curl-up and modified pull-up tests, only the number of repetitions correctly performed was recorded.

The 20-m shuttle run test was used to assess cardiorespiratory fitness of adolescents. The test data were processed using the equation proposed by Leger *et al*[18] to estimate the maximum oxygen consumption (VO_{2max}).

Sexual maturation was self-assessed by comparing illustrative photographs that displayed pubic hair development tables, as proposed by Marshall and Tanner[4] (Kendall correlation coefficient of 0.627 (p<0.01) for boys and 0.739 (p<0.01) for girls)[19]. For this procedure, students were individually instructed in a private room by an evaluator of the same sex of the adolescent. The evaluator explained the importance and objectives of the sexual maturation assessment, described the procedures for self-assessment and showed how to fill out the evaluation form. The participants were shown a board with photographs of five stages of pubic hair development and asked to carefully observe each photograph, and then score in the evaluation form which one of them most resembled his/her pubic hair at that time.

In the descriptive analysis of variables, median, mean and standard deviation values were used. The normality of data was assessed using the Kolmogorov-Smirnov test separately for each sex. Normal distribution for flexibility and body fat percentage was found after applying log_{10} data transformation.

To compare average values between sexes, the Student t test was used for variables showing normal distribution (flexibility and body fat percentage) and the non-parametric equivalent for the others (curl-up, modified pull-up, 20-m shuttle run test [VO_{2max}] tests). The owe-way analysis of variance (ANOVA) and post hoc Bonferroni test were applied for variables with parametric distribution in order to assess the differences between pubertal development stages separately for each sex. For non-normal variables, the Kruskal-Wallis test was applied. The confidence level adopted for the analysis was 95%. Data were entered into the Microsoft Excel® software and analyzed using the Statistical Package for Social Sciences (SPSS, IBM, USA) version 15.0.

Results

Table 1 shows the general characteristics of adolescents (10 to 17 years old) according to sex. Girls showed higher TRSF, SESF, body fat percentage and flexibility values. Boys showed higher mean values in power/muscular strength and cardiorespiratory fitness tests.

Table 2 shows the distribution of adolescents at the different sexual maturation stages according to sex. Higher

Table 2 - Sample distribution at different sexual maturation stages, São Bonifácio, SC, Brazil, 2010

Stages	Boys		Girls	
	n	%	n	%
P1	10	7.1	09	7.0
P2	34	24.1	26	20.2
P3	30	21.3	29	22.5
P4	45	31.9	55	42.5
P5	22	15.6	10	7.8
Total	141	100.0	129	100.0

Table 1 - General characterization of the sample (São Bonifácio, SC, Brazil, 2010)

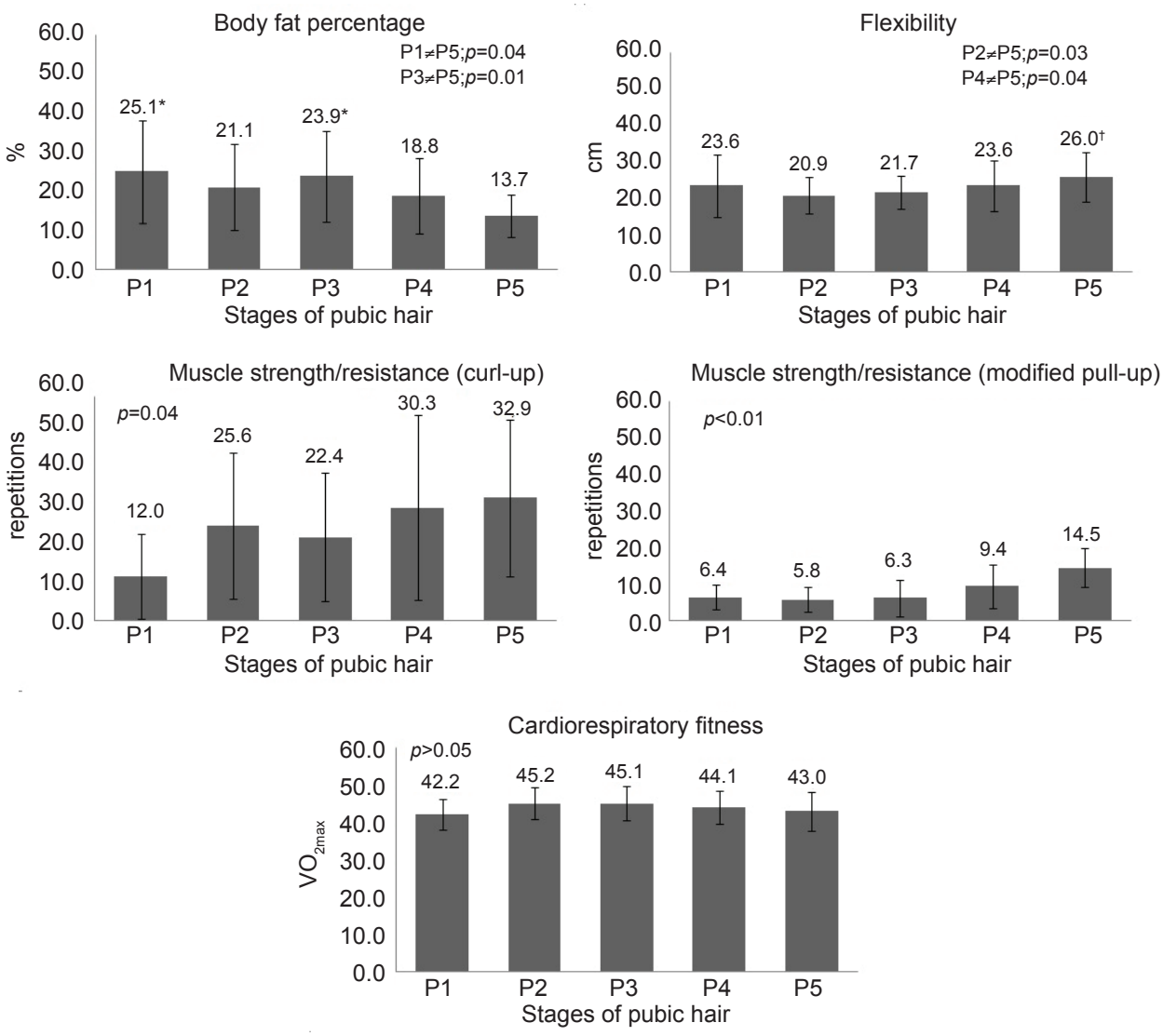
Variables	Boys					Girls					*p*
	n	$\bar{X}$	SD	Md	IIQ	n	$\bar{X}$	SD	Md	IIQ	
Age (years)	141	13.04	2.30	13.00	11.00–15.00	129	13.20	2.14	13.00	11.00–15.00	0.39
Body mass (kg)	141	54.09	16.44	54.10	41.50–63.05	129	54.25	14.50	54.80	44.40–62.55	0.73
Height (cm)	141	159.76	14.75	161.50	147.00–172.85	129	160.00	10.23	161.70	153.40–167.10	0.75
TRSF (mm)	141	13.40	6.93	11.20	8.00–17.05	129	18.32	6.81	17.30	13.65–21.45	<0.01
SESF (mm)	141	11.25	8.05	8.00	6.30–12.40	129	14.11	8.08	11.50	8.35–16.25	<0.01
Body fat (%)	141	20.08	10.64	16.74	12.07–26.36	129	26.53	8.89	25.08	20.69–30.20	<0.01
Flexibility (cm)	141	22.93	6.28	22.50	19.25–26.50	129	26.14	5.35	26.75	22.88–30.00	<0.01
Curl-ups (repetitions)	141	26.57	21.18	21.00	12.00–36.00	129	23.70	19.37	20.00	10.00–30.00	0.23
Pull-ups (repetitions)	141	8.48	5.78	7.00	3.00–12.00	129	3.29	2.78	3.00	1.00–5.00	<0.01
Cardiorespiratory fitness (VO_{2max})	141	44.27	4.56	44.56	41.51–47.40	127	40.64	5.08	41.15	37.23–44.57	<0.01

$\bar{X}$: mean; SD: standard deviation; Md: median; TRSF: triceps skinfold thickness; IIQ: Inter-quartile interval; SESF: subscapular skinfold thickness.

proportions of boys and girls during puberty period were observed (stage P2 to P4).

In boys (Figure 1), the mean fat percentage values were higher in stages P1 and P3 compared to those in post-pubertal maturation stage (P5). The differences were 11.4% in stage P1 in relation to P5 (p=0.04) and 10.2% in P3 (p<0.01) compared to the last stage (P5). For flexibility, an increase of 5.1cm was found from P2 to P5 (p=0.03). Adolescents belonging to stages P4 and P5 showed better performance on abdominal (p=0.04) and arm flexion tests (p<0.01). In the cardiorespiratory fitness, differences between sexual maturation stages were not observed (p>0.05).

In girls, only cardiorespiratory fitness differed between maturational stages (p<0.01). Visual observation of the graph indicates lower mean VO_{2max} values for adolescents in the most advanced maturation stages. Fat percentage and muscular fitness were similar between maturational stages (p>0.05) (Figure 2).



*Mean value greater than P5; †Mean value greater than P2 and P4.

Figure 1 - Mean values of the health-related physical fitness components for boys according to sexual maturation stages, São Bonifácio, SC, Brazil, 2010

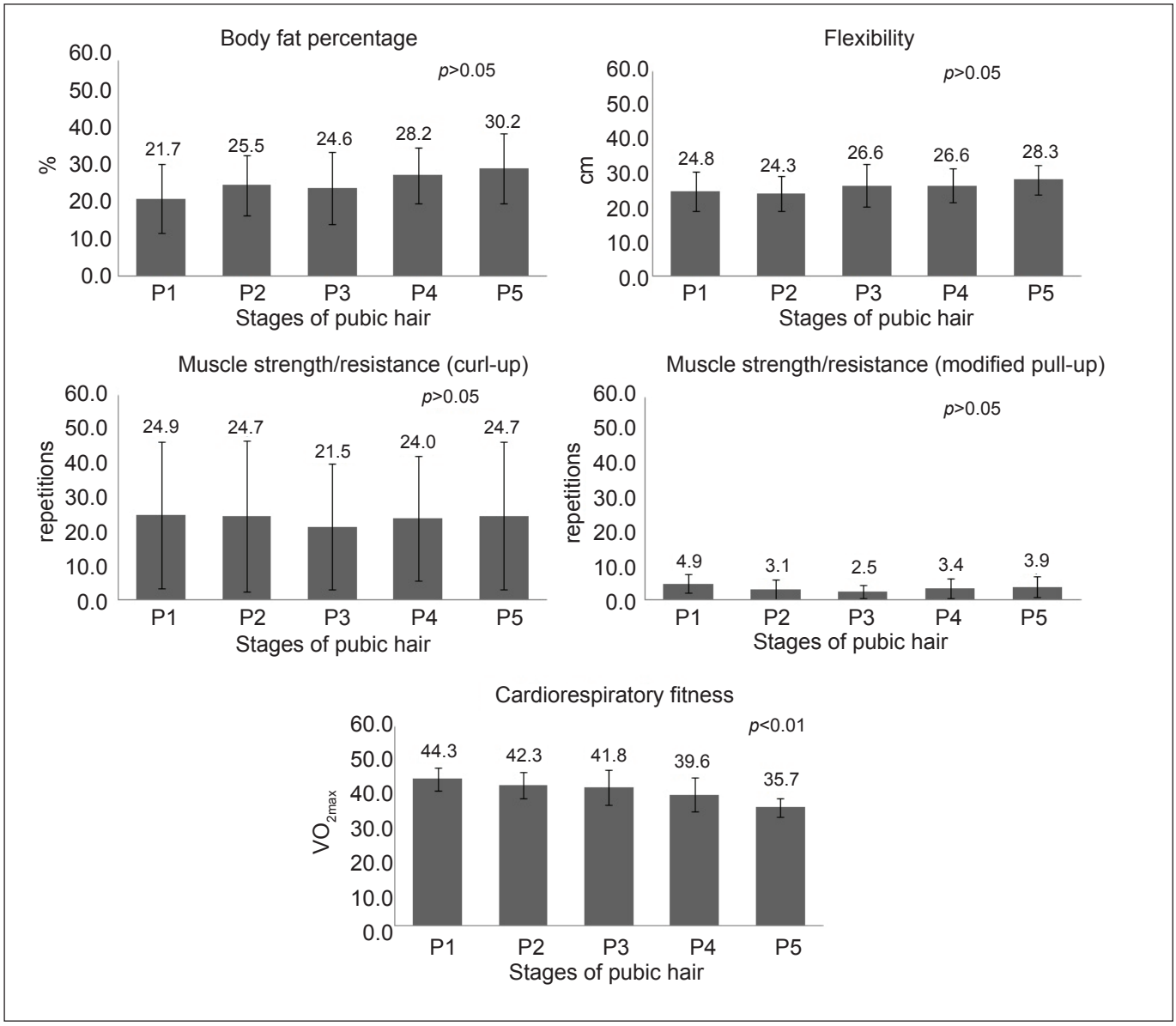


Figure 2 - Mean values of the health-related physical fitness components for girls according to sexual maturation stages. São Bonifácio, SC, Brazil, 2010

Discussion

For boys, the results of this study found lower mean body fat percentage values in post-pubertal stage. For flexibility and muscle strength/resistance, boys belonging to the most advanced sexual maturation stages achieved better performance in all tests. For girls, differences between stages were observed only for the cardiorespiratory fitness component, with lower VO_{2max} values for adolescents at more mature stages. Body composition and muscular fitness in girls and cardiorespiratory fitness in boys remained stable from pre-pubertal to post-pubertal stages. It should be noted that comparing the physical fitness components between sexes was not the aim of this study, but rather between sexual maturation stages in the same sex.

For boys, the mean body fat percentage values were lower and statistically significant with advancing sexual maturation stages until the end of the pubertal period. Contrasting these findings, differences between sexual maturation stages were not observed for students from São José dos Campos, SP, Brazil (10–12 years old)[5], a city of mixed population settled by Japanese, Italian, German and Portuguese, with high HDI (0.849).

In a longitudinal study conducted with boys (10–13 years old) from Ilhabela, in São Paulo State, Brazil, which

is a city of intermediate HDI (0.781) firstly inhabited by native Americans, with an economy based on tourism, trade and construction, 14–28% of body fat variation of adolescents from 10 to 12 years old was explained by sexual maturation[20]. Naturally, boys tend to show an increase in muscle mass with pubertal development[21]. In this study, lower mean body fat percentage values in adolescents living in a city of German colonization were found at the final maturation stages. The lower amount of body fat observed in these adolescents may be a result of changes in body composition that occur with puberty and the increasing overweight prevalence as a result of industrialization and urbanization. Modern times brought changes in eating habits and physical activity patterns, resulting in a global obesity outbreak[22]. Although this variable has not been investigated, evidence[9] showed that physically active adolescents have higher amounts of muscle mass and lower body fat percentage.

Similar mean body fat values between stages were observed in girls from the first to the last sexual maturation stage, contrasting to the findings for American girls[23], which showed an increase in the amount of body fat from P1 to P5. These differences were not evident in students (10–12 years old) from a Brazilian city of mixed population[5]. Naturally, due to the action of sexual hormones, a progressive increase in body fat was observed in girls with maturation[21]; however, their lower involvement in physical activities[9] and inadequate eating habits[22] may contribute to increased body fat percentage levels.

In boys, higher flexibility rates were observed in adolescents at the final maturation stages. In European adolescents (13.0 to 18.5 years old)[6], differences between sexual maturation stages in this component were also found after controlling body fat, fat-free mass and physical activity during leisure time, corroborating findings of the present study. The growth at different rates of bone and muscle structures, provided by the advent of puberty, contributes to the temporary reduction of this component, which tends to stabilize at the end of the growth period[3].

Flexibility in girls remained stable throughout pubertal development, as observed in girls from a city with high HDI (0.810) inhabited by southern settlers, mostly descendents of Polish, Germans, Italians, Ukrainians, and native people, in southern Brazil[8], and in girls from nine European countries, including Germany[9]. Researchers have reported a weak correlation between sexual maturation and flexibility, and the variability of this component is explained less than 2% by maturation, height and body mass index[8]. These data suggest that, among girls, flexibility is not substantially modified by the process of sexual maturation, regardless of the ethnic origin of the studied population. Probably, the genetic composition of muscles and connective tissues in females favors greater flexibility at all ages compared to males[21].

For power/muscular strength, the differences found between sexual maturation stages were not observed in boys, in both tests applied. Unlike the results of this study, differences were also found in young Brazilians athletes (14 to 16 years old)[24] and European adolescents (13.0 to 18.5 years old)[9] in handgrip and push-up tests, controlled by body fat, fat-free mass and physical activity during leisure time. In a longitudinal study, sexual maturation explained 12% of the variability in muscle strength as measured by vertical jump test in boys aged 10 and 12 years[20]. The gain in muscle mass provided by the advent of puberty[3,21] can contribute to differences found in power/muscular strength between sexual maturation stages. However, the similarity of this component between the stages observed in this study may be confounded by other variables which were not investigated, such as physical activity level.

In girls, differences in power/muscular strength were not observed with pubertal development, agreeing with the findings in European adolescents (13.0 to 18.5 years old)[9]. During puberty, gains of fat tissue prevail in girls and the gained muscle mass is less marked than in boys[21]. These biological changes that occur during adolescence may have had an impact on the similarity of power/muscular strength between sexual maturation stages observed in this study.

Cardiorespiratory fitness did not differ between sexual maturation stages among boys. A negative association between cardiorespiratory fitness and sexual maturation was found for Spanish and Swedish boys[6]; however, after adjusting for body fat percentage, this association disappeared. For European boys (13.0 to 18.5 years old)[9], a significant increase in cardiorespiratory fitness was observed throughout the stages completed in the test, with advancing sexual maturation stages. In this study[9], boys at stage P3 of maturation traveled almost 1.5 more stages in the physical test compared to boys at stage P5.

For girls, the cardiorespiratory fitness was different between the different sexual maturation stages,

corroborating the results found for European (13.0 to 18.5 years old)[9] and Brazilian adolescents living in cities of intermediate HDI in Northeast Brazil [25], inhabited by native people and settled by French and Portuguese immigrants. In Spanish and Swedish girls (13.0 to 18.5 years old)[6], after adjusting for body fat percentage, a negative association between cardiorespiratory fitness and sexual maturation was found, suggesting that body fat percentage is a modifying factor of the cardiorespiratory fitness. In a study conducted with girls from Northeast Brazil, negative and moderate correlations were found between maximum absolute oxygen consumption (r=-44) in relation to body mass (r=-28) and lean body mass (r=-0.65)[25]. The reduced cardiorespiratory fitness reported for girls is usually attributed to the effect of increased adiposity associated with maturation. However, if this decline remains even if controlled by body fat, the cause can be attributed to external factors and not to biological variables. Evidence shows a decrease in physical activity levels with advancing sexual maturation stages[26,27]. This suggests that the reduced physical activity level observed in this phase of life[27] can be a factor that contributes to the low cardiorespiratory fitness levels found.

As a limitation, the motivation of the adolescents to perform the tests, which was a variable not tested, may have influenced the results. Furthermore, the tests used to estimate muscular fitness are not the most suitable[28]; however, they were used for comparison with other studies. Furthermore, this is a cross-sectional study, which does not allow establishing causal relationships between the investigated variables and inferring increases or decreases in physical fitness components according to the sexual maturation stages, which was obtained by self-assessment and may have been influenced by cultural issues, although this is the recommended method in the literature[29]. The method of clinical evaluation performed by a pediatrician could avoid errors related to cultural issues. In addition, although the city investigated was of German colonization, and Germanic features were observed in the adolescents, it was not determined whether all adolescents who participated in this study were of German descendents. Finally, almost all adolescents enrolled in the public school system were included in the study, but the small number of students prevented the analysis of physical fitness components by controlling the chronological age. Furthermore, the small number of adolescents at each sexual maturation stage may have hindered the observation of significant differences in comparisons between stages.

Among the strengths of this study, the sample selected is representative of the population of students from São Bonifácio, SC, Brazil, since, according to information from school offices, there were no dropouts in 2010. In addition, the tests used to assess body composition and cardiorespiratory fitness are the most widely used for these purposes[28]. Moreover, the analyses of the physical fitness components were conducted according to the sexual maturation stages in a sample composed of adolescents with similar socio-cultural characteristics, which reduces disparities between individuals. These results are valid for adolescents within the age group investigated, living in a small town of German colonization. Further studies that take into account the sociodemographic, cultural ethnic origin aspects should be conducted for better understanding of the physical fitness in this context.

In conclusion, the results showed lower body fat percentage at the final sexual maturation stages in boys. For muscular fitness, higher flexibility and muscular strength/resistance levels were found in adolescents belonging to the most mature stages. For girls, differences between sexual maturation stages were observed only for the cardiorespiratory fitness component, with average VO_{2max} values lower for those at the final stages. Body fat percentage and muscular fitness for girls and cardiorespiratory fitness for boys showed similar results between sexual maturation stages.

These results are useful for the planning of public policies aimed at the health of adolescent students. Effective intervention programs are needed to promote satisfactory levels of health-related physical fitness in these adolescents, especially for boys at early sexual maturation stages and girls at the most advanced sexual maturation stages.

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