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CAN SCHOOL SPORT PARTICIPATION INCREASE CARDIORESPIRATORY FITNESS AND CARDIORESPIRATORY RESPONSE TO EXERCISE? A PILOT STUDY IN 14 AND 15 YEAR OLD BOYS

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ABSTRACT

Background: Even though adolescents are engaged in physical activity during physical education (PE) classes, this does not guarantee that they experience intensity levels high enough to induce physiological adaptations, such as increasing cardiorespiratory fitness. Objective: This study aimed to compare the cardiorespiratory response to exercise, by analyzing the maximum oxygen consumption (VO_2 max), the ventilatory anaerobic threshold (VAT) and the respiratory compensation point (RCP) parameters, of adolescent boys participating only in PE or in PE and school sports (SS). Methods: Twenty-five 14 to 15-year-old boys participated in the study. Students were divided into two groups whether they practice only PE (PE group; n=9) or PE and SS (PE+SS group; n=16). Weight, height, and percentage of body fat were measured. The cardiorespiratory response to exercise was analysed using a gas analyser and performed in a treadmill. The protocol consisted of constant and small increases in speed and slope. To identify ventilatory thresholds (VAT and RCP) combinations of visual and computerized criteria were used. Groups were compared using Students t-test. The significance level was set at $p<0.05$. Results: Students from the PE+SS group had higher VO_2 (mL/kg/min) ($p<0.05$) and speed ($p=0.001$) than the PE group at the VO_2 max, VAT and RCP parameters. Only in the VAT, the PE+SS group had higher $\%VO_2$ max ($p=0.033$) than the PE group. No significant differences were found between the two groups. Conclusion: The stimuli generated during SS, along with PE classes may have a significant effect on the students' cardiorespiratory fitness, on submaximal and maximum parameters.

Key words: Adolescents. School. VO_2 max. Physical education.

RESUMO

A participação do esporte escolar, pode aumentar a aptidão cardiorespiratória e a resposta cardiorespiratória ao exercício? Um estudo piloto em meninos de 14 e 15 anos

Mesmo que os adolescentes pratiquem atividades físicas durante as aulas de educação física, isso não garante que vivenciem níveis de intensidade altos o suficiente para induzir adaptações fisiológicas, como o aumento da aptidão cardiorrespiratória. Este estudo teve como objetivo comparar a resposta cardiorrespiratória ao exercício, por meio da análise do consumo máximo de oxigênio dos parâmetros do limiar anaeróbio ventilatório e do ponto de compensação respiratória, de adolescentes do sexo masculino participantes apenas de EF ou em EF e esportes escolares (SS). 25 meninos de 14 a 15 anos participaram do estudo. Os alunos foram divididos em dois grupos, independentemente de praticarem apenas EF (grupo EF; n=9) ou EF e SS (grupo EF + SS; n=16). Peso, estatura e porcentagem de gordura corporal foram medidos. A resposta cardiorrespiratória ao exercício foi analisada em analisador de gases e realizada em esteira. O protocolo consistia em aumentos constantes e pequenos na velocidade e na inclinação. Para identificar os limiares ventilatórios, foram utilizadas combinações de critérios visuais e computadorizados. Foram comparados, o teste t de Student. Os escolares do grupo PE + SS apresentaram VO_2 (mL / kg / min) e velocidade ($p=0,001$) maiores do que o grupo PE nos parâmetros VO_2 máx, VAT e PCR. Apenas no VAT, o grupo PE + SS apresentou% VO_2 max maior ($p=0,033$) do que o grupo PE. Não foram encontradas diferenças significativas entre os dois grupos. Os estímulos gerados durante o SS, juntamente com as aulas de EF podem ter um efeito significativo na aptidão cardiorrespiratória dos alunos, nos parâmetros submáximos e máximos.

Palavras-chave: Adolescentes. Escola. VO_2 máx. Educação Física.

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INTRODUCTION

Cardiorespiratory fitness (CRF) is an important component of physical fitness and has been used as an indicator of sports performance (Oliveira, Santos, 2012) and health (Ortega et al., 2008) in adolescents.

Besides the immediate benefits (De Rose et al., 2009), improving CRF in adolescents is essential, as it leads to a healthy lifestyle and greater aerobic capacity during adulthood (Balassiano, Araújo, 2013).

The maximum oxygen consumption (VO_2 max), the ventilatory anaerobic threshold (VAT) and the respiratory compensation point (RCP) are parameters commonly studied when assessing CRF and are considered reliable markers due to their sensitivity to sedentarism and aerobic deconditioning (Perez, Carletti, 2012; Armstrong, Welsman, 2001; Chintala, 2008).

Since adolescents spend most of their time at school, schools can play an important role in promoting healthy lifestyles and improving physical fitness, especially through physical education (PE) and extracurricular activities, such as school sports (SS) (Pate et al., 2006; Seabra et al., 2007).

Additionally, sports participation within the school context is reinforced by the safe environment that it provides, especially when insecurity is set as one of the factors that contribute to low levels of participation (Bonierski, 2008; Kirby, 2011; Santos, Simões, 2007).

Even though adolescents are engaged in physical activity during PE classes, this does not guarantee that they experience intensity levels high enough to induce physiological adaptations, such as increasing CRF (Guedes, Guedes, 2001; Tornquist, et al., 2013).

In result, extracurricular sports activities may be essential to increase physical activity and CRF levels among adolescents (Drake et al., 2012; Coledam et al., 2014).

Participation in extracurricular sport activities, such as SS, is considered a strategy to increase physical activity and CRF levels among adolescents (Stabelini Neto et al., 2007), however few studies (Grego et al., 2006; Stabelini Neto et al., 2007; Souza et al., 2013) compare the physiological cardiorespiratory response to exercise of adolescent participating in these extracurricular activities and those participating only in PE.

Therefore, the present study aimed to compare the physiological cardiorespiratory response to exercise, by analyzing the VO_2 max, the VAT and the RCP parameters, of adolescent boys participating only in PE and participating in PE and SS.

MATERIAL AND METHODS

Study design and participants

This cross-sectional study compared a sample of middle and high school students, who participated in PE and in SS, from a school in Vitóri-ES, Brazil. Both PE classes and SS sessions were conducted by the schoolteachers.

Eligibility criteria for participation in the study were: (a) being male; (b) aged between 14 and 15 years old; (c) able to participate in physical activities without limitations; (d) participating in at least 90% of PE classes; and (e) not participating in any sporting activity outside school. The total sample comprised 25 students, who were divided into two groups whether they participated only in PE (PE group, n=9) or if they participated in PE and SS (PE+SS group, n=16).

The study protocol was approved by the Ethics Committee of the Federal University of Espírito Santo (no. 2.061.598). All procedures were explained to the students and their legal guardians and only those who agreed to participate and signed the informed consent were included in the study.

Measures

Anthropometric measurements

Weight and height were measured using an anthropometric electronic scale (Marte, model LC200, Minas Gerais, Brazil), with a precision of 0.1 kg and a maximum capacity of 200 kg, and a stadiometer with a 0.1 cm precision. The body mass index (BMI) was calculated as weight (kg)/ height^2 (m).

The percentage of body fat was calculated from two skinfold measurements (triceps and leg) using an adipometer (Mitutoyo / CESCORF, Porto Alegre-RS). A specific formula for adolescents' boys (%= 0.735 (sum of skinfolds) + 1.0) was used (Slaughter et al.,1988).

Sexual maturation

Maturation was self-assessed using the Tanner scale for the maturational stage (Tanner,1962), validated by Matsudo and Matsudo (1994).

Cardiopulmonary exercise testing (CPET)

Before the CPET, the students were submitted to a rest 12-lead electrocardiogram (ECG) (TEB system, model SM 400, Porto Alegre-RS, Brazil).

The ECG was performed while the students were lying down, after a 5-minute rest period, in a climatized environment without noise.

The CPET was performed on a treadmill ergometer (Inbrasport Super ATL, Rio Grande do Sul, Brazil) using a maximal test. The treadmill protocol consisted of constant and small increases in speed (from 5 to 10 km/h for the PE group: and from 5 to 12 km/h for the PE+SS group) and slope (from 0% to 5%).

These speed and slope values were reached within 10 minutes. To identify maximal effort the following criteria, proposed by Rowland and Cunningham (1992), were considered: (a) exhaustion or inability to maintain the required speed; (b) respiratory exchange rate (RER) higher than 1; and (c) achieving maximal heart rate (HRmax), classified as more than 190 bpm. The test was considered valid only when two of these criteria where met. When the students did not achieve the maximal effort within the 10 minutes of the protocol, the test was continued following the protocol's gradual increases.

The physiological cardiorespiratory response to exercise was analyzed using the Cortex Metalyzer 3B gas analyzer (Germany), which provides information about the oxygen consumption (VO_2), carbon dioxide production (VCO_2), pulmonary ventilation (VE), ventilatory equivalent of oxygen ($VEqO_2$ = VE / VO_2) ventilatory equivalent of carbon dioxide ($VEqCO_2$ = VE / VCO_2) and respiratory exchange rate (RER = VCO_2 / VO_2).

To identify ventilatory thresholds (VAT and RCP) combinations of visual and computerized criteria, calculated by Metasoft software (Leipzig, Germany), were used. The VAT was identified at the time of the lowest point followed by an exponential increase in the $VEqO_2$, without increasing the $VEqCO_2$.

Additionally, a computerized V-slope method to identify VAT was used. This method indicates the interception point between VO_2 and VCO_2.

To identify the RCP the lowest point of $VEqCO_2$ with subsequent increasing after the gradual drop of PETCO2 was considered. The parameters were analyzed by two experienced evaluators, and, in case of disagreement, a third evaluator was requested.

Statistical analysis

Descriptive statistics including age, height, weight, BMI and fat percentage were calculated for all individuals. The student's t test (when variables had normality) and the Mann-Whitney test (when variables did not have normality) were used to compare data between the two groups. Statistical analysis was performed using the SigmaStat® 3.5 programs and the significance level was set at $p<0.05$.

RESULTS

Table 1 presents the characteristics of the sample. All students were considered as pubertal or post-pubertal according to Tanner (1962) criteria, with the PE group being characterized as 69% and 31% and the PE+SS group as 78% and 22%, respectively.

No significant differences were found between groups considering age, height, weight, BMI and fat percentage.

Table 1 - Anthropometric characteristics of the participants by group.

	M±SD		
	PE group (n= 9)	PE+SS group (n= 16)	p
Age (years)	14.67±0.50	14.69±0.48	0.919
Stature (m)	169±0.07	166±0.05	0.264
Weight (kg)	66.58±19.32	58.71±7.05	0.152
BMI (kg/m^2)	23.11±5.88	21.21±2.23	0.255
Fat %	16.24±8.24	14.62±5.44	0.557

BMI, body mass index; M, mean; SD, standard deviation; PE, physical education; SS, school sports.
Independent sample Student t-test was used to compare groups.

The comparison of the physiological cardiorespiratory response to exercise, in the VO2max, the VAT and the RCP parameters, between the PE group and the PE+SS group is presented in table 2.

In the VO_2 max parameter, the PE+SS group presented higher VO_2 (mL/kg/min) (54.75±5.63 vs. 46.89 ±6.62, p=0.004) and speed (13.28±0.95 vs. 10.45 ±1.35, p=0.001) than the PE group. In the VAT parameter the PE+SS group presented higher VO_2 (mL/kg/min) (35.9 ±6.9 vs. 26.2±4.8, p=0.001), %VO_2 max (66.3±10.3 vs. 56.4 ±10.6, p=0.033) and speed (8.64±1.1 vs. 7.0 ±0.5, p=0.001) than the PE group. Similarly, in the RCP parameter, the PE+SS group presented higher VO_2 (mL/kg/min) (50.7±5.7 vs. 41.9 ±7.2, p=0.003) and speed (12.0±1.1 vs. 9.5±1.1, p=0.001) than the PE group.

Table 2 - VO_2, heart rate and speed in the VO_2 max, VAT and RCP parameters for both groups.

		M±SD		
		PE group (n= 9)	PE+SS group (n= 16)	p
VO_2 max	Pulmonary Ventilation	102.73±20.62	106.94±20.54	0.579
	HR (bpm)	195.67±5.89	197.92±5.45	0.424
	VO_2 (mL.kg-1.min-1)	46.89±6.62	54.75±5.63	0.004
	VO_2 (L. min-1)	3.05±0.62	3.20±0.41	0.466
	RER	1.06±0.07	1.06±0.04	0.948
	Speed (km/h)	10.45±1.35	13.28±0.95	0.001
VAT	VO_2 (mL.kg-1.min-1)	26.2±4.8	35.9±6.9	0.001
	%VO_2 max	56.4±10.6	66.3±10.3	0.033
	HR (bpm)	137±17.0	148±21.5	0.205
	% HRmax	74.7±10.8	74.7±8.3	0.997
	RER	0.80±0.0	0.80±0.0	0.440
	Speed (km/h)	7.0±0.5	8.64±1.1	0.001
RCP	VO_2 (mL.kg-1.min-1)	41.9±7.2	50.7±5.7	0.003
	%VO_2 max	88.5±6.1	91.5±4.5	0.182
	HR (bpm)	180±10.8	184±17.0	0.220
	% HRmax	91.3±4.8	91.5±6.2	0.550
	RER	1.00±0.0	0.95±0.1	0.499
	Speed (km/h)	9.5±1.1	12.0±1.1	0.001

VO_2 max, maximum oxygen consumption; VAT, ventilatory anaerobic threshold; RCP, respiratory compensation point; HR, heart rate; RER, respiratory exchange rate; M, mean; SD, standard deviation; PE, physical education; SS, school sports.
Independent sample Student t-test was used to compare groups.

DISCUSSION

This study sought to compare the physiological cardiorespiratory response to exercise in the VO_2 max, VAT and RCP parameters, of adolescent participating only in PE and adolescents participating in PE and SS. Findings showed that the students that also practiced SS had higher VO_2 and were faster in each parameter than the students who only practiced PE. Thus, being involved in SS together with PE provides a better cardiorespiratory response to exercise than practicing only PE.

Accordingly, to the literature (Rodrigues et al., 2006), the adolescents who practiced PE and SS had optimal CRF, while those who practice only PE had regular CRF. Furthermore, the VO_2 max levels reached by the PE+SS group are similar to those of athletes of the same age (Mascarenhas et al., 2006; Oliveira et al., 2007).

These results are similar with previous study (Colantonio et al. 1999), where VO_2 max was measured indirectly in a group of students participating in PE and other group participating in a sports training program.

Similarly, to the maximal parameter, in the submaximal parameters (VAT and RCP) the PE+SS group had higher VO_2 consumption than the PE group. The differences found between the two groups may be explained by the higher frequency, volume, and intensity of the training sessions.

The results on the running speed showed that the PE+SS group endures running at a greater velocity, than the PE group, before achieving the VAT and the VO_2 max parameters.

Thus, suggesting that practicing SS alongside PE enhances the cardiorespiratory response to exercise. The better speed performance in the PE+SS group may be attributable to the training stimuli, namely in intensity, received during the SS sessions (Silva, et al., 1999).

As the intensity increases, the predominant energy substrate used changes due to the fast-twitch fibers' recruitment. Following this idea, it is possible to link the better speed performance in both thresholds for the PE+SS group to the improved use of energy sources at submaximal levels due to training.

Several studies report that CRF is inversely associated with BMI and body fat (Dumith, et al., 2012; Minatto, 2013; Capel et al., 2014). In this study, although the PE+SS group had better CRF than the PE group, no differences were found regarding the BMI or body fat. This may be due to the small sample size.

This study has some limitations that should be acknowledged. The intensity of the SS training sessions was not monitored, and this could influence the results as the intensity of exercise is related to CRF. This is a cross-sectional study which does not allow establishing causality.

Future studies with larger samples and with a longitudinal design are needed to better understand

the impact of SS in the CRF of students. Notwithstanding, this study also has some strengths. The respiratory parameters were assessed directly using a gas analyzer. The pubertal stages of the students were known and were similar. This is important as maturity plays an important role in the development of the CRF in adolescence (Guedes, Guedes, 1995; Ferrari, et al., 2009).

CONCLUSION

Findings suggest that the stimuli generated during PE classes, along with systematized after-school training (SS) may have a significant effect on the students' CRF, on submaximal and maximum parameters.

Therefore, practicing SS can be used as a useful strategy to increase CRF in adolescents.

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