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Original Article

ASSOCIATION BETWEEN FREQUENCY OF PHYSICAL EDUCATION CLASSES AND HEART RATE VARIABILITY IN ADOLESCENTS BOYS: A CROSS-SECTIONAL STUDY

ASSOCIAÇÃO ENTRE FREQUÊNCIA DE AULAS DE EDUCAÇÃO FÍSICA E VARIABILIDADE DE FREQUÊNCIA CARDÍACA EM MENINOS ADOLESCENTES: UM ESTUDO TRANSVERSAL

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RESUMO

A inatividade física está associada à baixa variabilidade da frequência cardíaca (VFC) em adolescentes. Entretanto, não está claro se o número de aulas de Educação Física (EF) causa impacto na VFC. Este estudo transversal verificou a associação entre a frequência das aulas de EF com parâmetros de VFC em adolescentes do sexo masculino. Foram incluídos 1.152 meninos (16,6 ± 1,2 anos). A quantidade de aulas de EF foi avaliada através de questionário e os adolescentes foram estratificados de acordo (nenhuma aula de EF; uma aula de EF / sem; ≥2 aulas de EF / sem). Os domínios do tempo (SDNN, RMSSD, PNN50) e da frequência (LF, HF, balanço simpático-vagal) da VFC foram obtidos. Modelos Lineares Generalizados foram usados para comparar os parâmetros da VFC de acordo com a quantidade de aulas de EF, ajustando para fatores de confusão. Não houve diferença nas medidas de VFC de tempo: (SDNN, p = 0,77; RMSSD, p = 0,72; PNN50, p = 0,83) e frequência (LF, p = 0,61; HF, p = 0,61; balanço simpatovagal, p = 0,60) entre as diferentes frequências das aulas de EF. A frequência das aulas de EF não está associada aos parâmetros de VFC de adolescentes do sexo masculino.
Palavras-chave: Educação Física. Adolescente. Sistema nervoso autônomo.

ABSTRACT

Physical inactivity is associated with low heart rate variability (HRV) in adolescents. However, whether the number of physical education (PE) classes impact HRV remains unclear. This cross-sectional study verified the association between the frequency of PE classes and HRV parameters in male adolescents. This study included 1152 boys (16.6 ± 1.2 years). The quantity of PE classes was assessed though questionnaire and the adolescents were stratified accordingly (no PE class; one PE class/wk; ≥2 PE classes/wk). Time- (SDNN, RMSSD, PNN50) and frequency-domains (LF, HF, sympathovagal balance) of HRV were obtained. Generalized Linear Models were used for comparing the HRV parameters according to the quantity of PE classes, adjusting for confounders. There was no difference in HRV measures of time: (SDNN, p = 0.77; RMSSD, p=0.72; PNN50, p=0.83) and frequency (LF, p=0.61; HF, p=0.61; sympathovagal balance, p=0.60) between the different frequencies of PE classes. The frequency of PE classes in not associated with HRV parameters of male adolescents.
Keywords: Physical Education. Adolescent. Autonomic nervous system.

Introduction

The heart rate variability (HRV) describes the oscillations among consecutive heartbeats, which reflects the heart’s ability to respond to physiological stimuli, being a non-invasive measure widely used to assess cardiac autonomic modulation[1]. A low HRV is indicative of an imbalance between parasympathetic and sympathetic cardiac control.

In children and adolescents, low HRV has been associated with high blood pressure[2] and abdominal obesity[3]. On the other hand, physical activity has been associated with higher HRV[2,4] regardless of obesity and hypertension[5] suggesting that the physical activity level can act in a cardioprotective manner in adolescents. Physical education (PE) classes is one way to promote physical activity between children and adolescents [6]. Studies have indicating that higher frequency of PE classes are associated with better physical fitness[7,8]. Therefore, the frequency of PE classes may also be associated with HRV. Thus, the aim of the present study was to analyze the association between PE class attendance and HRV parameters in male adolescents.

Methods

Sample

The cross-sectional study protocol was approved by the Ethics Committee of the University of Pernambuco in accordance with the Guidelines of the National System of Research Ethics. The study population were adolescent boys aged 14 and 19 years from public high schools in the state of Pernambuco, Northeastern Brazil.

The sample was balanced for geographical distribution, school size, and the period of the day that students attended school. Geographical distribution considered the number of students enrolled in each of the 17 school districts. School size was divided into small (<200 students), medium (200 to 499 students), and large (≥ 500 students). The period of the day was divided into daytime and evening. A two-stage cluster sampling procedure was performed to select the required sample. In the first stage, schools were selected by school district. In the second stage, size and period of the day were considered. Selection was performed after generating random numbers using statistical software, and class was used as the sampling unit for the final stage of the process.

Participated in this study, all students who were in the classroom on the data collection day and had previously obtained parental or guardian consent. However, for HRV assessment, only boys without diabetes mellitus, cardiovascular disease, neurological or mental disabilities were included. Likewise, those adolescents who had ingested caffeinated or alcoholic beverages, any form of tobacco or illicit drugs, or performed physical exercise 12 hours before assessment of HRV were excluded.

Procedures

The procedures of the present study have been described elsewhere[2, 4, 5, 9-11]. Data collection was performed between May and October in 2011.

Instruments

The frequency of PE classes (exposure) was assessed through the following question: "During a typical week, how many physical education classes do you normally participate in?" Adolescents were classified as: a) do not participate in any physical education classes; b) participate in one lesson a week; and, c) participate in two or more classes per week.

The HRV measurement (outcomes) was carried out in a quiet room within the school during the class time. After 30 minutes at rest in a supine position, adolescents had their RR intervals continuously recorded for 10 minutes. These records were obtained through a cardiofrequencimeter (POLAR, RS 800CX, USA). After registration, RR intervals were analyzed using the Kubios HRV software (Biosignal Analysis and Medical Imaging Group, Joensuu, Finland). This software was operationalized by blind researcher according to the recommendations of the Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology[1]. The intraclass coefficient of correlation of this evaluator ranged from 0.982 to 1.00[12].

The time and frequency domain indexes were analyzed using the HRV spectral analysis. The spectral components were calculated using the autoregressive method and the model order was chosen according to the Akaike's criterion. The power of each spectral component was normalized by dividing the power of each band in the spectrum by the total variation, minus the value of the very low frequency band (<0.04 Hz) and multiplying the result by 100. To interpret the time domain parameters, the standard deviation of all RR intervals (SDNN), the root mean square of the squared differences between adjacent normal RR intervals (RMSSD) and the percentage of adjacent intervals over 50 ms (PNN50). To interpret the parameters of the frequency domain, the normalized components of low frequency (LF) and high frequency (HF) of the HRV were considered as predominantly representatives of the sympathetic and vagal modulations of the heart, respectively, and the relationship between these bands (LF/HF) was defined as the cardiac sympathovagal balance.

Physical activity level (confounder) was assessed by the question "During the past 7 days on how many days were you physically active for a total of at least 60 minutes per day?" Adolescents were classified as active or physically inactive as previously published[2,4,5,9]. Reproducibility indicators (i.e., test- retest consistency, 1-week apart) showed the kappa coefficient to be 0.60 and Spearman ' s rank correlation coefficient to be 0.82[13]. *Adolescents with abdominal obesity* (confounder) were considered those with waist circumference above the 80th percentile for their respective age[14]. *The high blood pressure (confounder)* was considered as having systolic and/or diastolic blood pressure values above the 95th percentile, recommended for their respective age and height [15].

Statistical analysis

Data analyses were conducted using the Statistical Package for the Social Sciences software e SPSS/PASW version 20 (IBM Corp, New York, NY). Descriptive statistics included mean and standard error for numerical variables, whereas the categorical ones were presented as percentage. One-way ANOVA (followed by Tukey's post-hoc) and Chi-square tests were applied to examine whether adolescents' characteristics differed among PE classes groups. Generalized Linear Models were used for comparing the HRV parameters according to the frequency of PE classes, including physical activity, abdominal obesity, high blood pressure, age and time of day as covariates[2]. A $p<0.05$ was considered statistically significant.

Results

Sixty out of 1212 boys presented with low signal quality (stationary periods of the tachogram length lower than 5 minutes), therefore, the final sample size was 1152 participants. The table 1 summarizes the general characteristics of the participants according to the frequency of PE classes. Adolescents who had no PE classes were older, taller, and weightier. Likewise, higher proportions of abdominal obesity and physical inactivity were also found among them.

Table 1. Adolescents' general characteristics according to the quantity of physical education classes (n = 1152)

	No class (*n*=252)		1 class (*n*=472)		≥ 2 classes (*n*=426)		*p*
	M	*SD*	*M*	*SD*	*M*	*SD*	
Age (years)	16.8	1.3	16.6	1.3	16.5	1.2*	0.002
Weight (kg)	65.7	14.1	63.3	11.9*	62.9	12.0*	0.014
Height (cm)	172.1	6.8	171.9	7.4	171.1	6.60	0.157
Body mass index (kg/m²)	22.2	4.4	21.4	3.5*	21.4	3.5*	0.019
Waist circumference (cm)	78.2	10.7	76.3	9.0*	76.1	8.9*	0.008
Abdominal obesity (%)	20.6 (15.9-25.9)		14.0 (11.1-17.3)*		13.6 (10.6-17.1)*		0.029
High blood pressure (%)	12.7 (9.0-17.2)		8.7 (6.4-11.5)		8.9 (6.5-11.9)		0.182
Insufficiently active (%)	69.7 (63.9-75.2)		65.5 (61.1-69.7)		60.1 (55.4-64.7)*		0.035

Note: *M* = Mean; *SD* = Standard deviation or percentage (95%CI). *p<0.05, statistically different from no class.
Source: Authors

Tables 2 shows the HRV's parameters in the different groups in according to participation in PE classes. No differences were found in any HRV parameters among PE classes groups (p> 0.05 for all).

Table 2. Heart rate variability indexes in the groups with different frequency of physical education classes

	No class (*n*=252)		1 class (*n*=472)		≥ 2 classes (*n*=426)		*ES*	*p*
	M	*SD*	*M*	*SD*	*M*	*SD*		
SDNN (ms)	62.5	23.8	62.1	23.9	61.1	22.7	0.025	0.694
RMSSD (ms)	54.7	28.6	53.8	28.2	55.3	28.9	0.023	0.749
PNN50 (%)	29.8	25.4	29.9	26.1	30.3	26.8	0.001	0.948
Low frequency (un)	53.3	17.5	53.2	17.8	52.2	16.5	0.002	0.612
High frequency (un)	46.7	17.5	46.8	17.8	47.8	16.5	0.002	0.612
Sympathovagal balance	1.47	0.79	1.46	0.87	1.39	1.03	0.040	0.500

Note: *M*=mean; *SD*=standard-deviation; *SDNN*= Standard deviation of all RR intervals; *RMSSD* = root mean square of the squared differences between adjacent normal RR intervals; *PNN50* = percentage of adjacent intervals over 50 ms. Adjusted for physical activity, abdominal obesity, high blood pressure, age and time of day
Source: Authors

Discussion

This study compared the HRV parameters according to the frequency of PE classes in adolescent boys. The results indicated similar HRV parameters among adolescents who performed none, one or 2≥ weekly PE classes.

Prior studies have consistently found greater HRV parameters among physically active adolescents compared to the insufficient active ones[2,4,5]. The current study demonstrated that the frequency of physical inactive adolescents was higher in the group that reported not perform PE classes, reinforcing the importance of PE classes to enhance physical activity levels in this group[6]. In addition, the adolescents who reported not perform PE classes had also higher body mass index and abdominal obesity, which may be partially explained by the low physical activity levels, and consequently, low energy expenditure[16]. Further studies are required to scrutinize other pathways through PE classes might have an impact on obesity measures.

The results of this study indicated that HRV parameters was not associated with the frequency of PE classes. The intensity of PE classes may be related to these results. Increases in parasympathetic modulation to the heart have been observed after 4-months of moderate intensity in obese adolescents[17]. In same way, Farah et al[18] demonstrated that only high-intensity exercise training increased parasympathetic parameters (ie. RMSSD, PNN50, and LF), while no changes were observed following low-intensity exercise training. Kremer et al.[19] observed that the time spent at moderate to vigorous physical activity represented approximately 44.1% of the PE class in male high school students. Similarly, Ferreira et al.[20] found even lower values (i.e. 28.2%). Therefore, it is possible that intensity of PE classes is not enough to improve HRV parameters.

The present study has some strengths as the sample size and HRV analysis by a single and blinded evaluator. However, some limitations of this study should be considered. The cross-sectional design and the correlative nature of the data preclude us from establishing a causal relationship between PE classes and HRV parameters. The HRV recording was carried out in different periods, which possibly results in different configurations of the PE classes, the ones was assessment by a questionnaire and setting the class has not been evaluated (e.g., circulation time or intensity). Although the participants' ages were tightly controlled, we could not determine the Tanner stage of the participants. Similarly, we were not able to include the measurement of cardiorespiratory fitness and strength muscle. Finally, this study represents a specific region of the country, which limits the ability to generalize the findings.

Conclusion

The frequency of PE classes is not associated with HRV in male adolescents. Future studies analyzing the impact of the intensity of PE classes on HRV should be carried out.

Human Subjects Approval Statement

Ethics Committee of the University of Pernambuco in compliance with the Brazilian National Research Ethics System Guidelines has approved the study. Parental consent to participate was obtained for all adolescents of the sample with under 18 years old.

Conflict of interest

All authors of this article declare they have no conflicts of interest.

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