Universidade de Aveiro
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Escola Superior de Saúde
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Sara Daniela Quina Rodrigues

ASSOCIATION BETWEEN PHYSICAL ACTIVITY AND CARDIORESPIRATORY FACTORS IN ADOLESCENTS: A CROSS-SECTIONAL EXPLORATORY STUDY

Associação entre a atividade física e os fatores cardiorrespiratórios em adolescentes: estudo exploratório transversal

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Dissertação apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Fisioterapia, realizada sob a orientação científica da Doutora Alda Sofia Pires de Dias Marques, Professora Adjunta da Escola Superior de Saúde da Universidade de Aveiro

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keywords

Adolescents; Healthy; Cardiorespiratory Fitness; Physical Activity Index; Incremental Shuttle Walking Test; Physical Activity

abstract

Background: Currently, under half of the adolescents reach recommended daily levels of physical activity (PA). It is known that higher levels of PA lead to higher levels of cardiorespiratory fitness (CRF) and therefore, a health-related CRF criterion value could contribute to identify the target population for primary cardiovascular disease prevention. Therefore, the aim of this study was to explore the relation between PA levels and CRF factors in healthy adolescents.
Methods: A cross-sectional exploratory study with healthy adolescents aged 12-18 years old was conducted. Socio-demographic and body composition data were collected using a questionnaire. PA level was scored with the Physical Activity Index (PAI) and CRF assessment included lung function (LF) measured with spirometry and exercise tolerance measured with Incremental Shuttle Walking Test (ISWT). According to PAI scores the sample was divided in two groups: 1 (sedentary, low and moderately active); 2 (vigorously active (VA)). Descriptive statistics were applied to characterise the sample. Independent sample t-tests assessed differences between groups and simple logistic regressions identified the predictors of being VA.
Results: The study included 115 adolescents (14.63±1.70 years old; 56.52% female). Adolescents presented a normal body mass index=21.19±3.14 $Kg.m^{-2}$) and LF (forced expiratory volume in the first second (FEV_1)=105.58±12.73% of the predicted). Significant differences were found between groups in height (G1–163.44±8.01; G2–167±8.65; p=0.024), LF (FEV_1/ forced vital capacity (FVC); G1–97.58±10.66; G2–94.04±8.04; p=0.049), ISWT distance (G1–1089.81±214.04; G2–1173.60±191.86; p=0.038); heart rate (HR) at rest (G1–84.61±13.68; G2–79.23±13.81; p=0.038), HR at the end of the best ISWT (G1–124.71±37.57; G2–133.54±33.61; p=0.041) and percentage of the maximal HR achieved during ISWT (G1–63.09±19.03; G2–67.53±17.08; p=0.043). Simple logistic regressions showed that height (OR–1.054; 95%CI 1.006-1.104), ISWT distance (OR–1.002; 95%CI 1.000-1.004) and HR at rest (OR–0.971; 95%CI 0.945-0.999) were predictors of being VA.
Conclusions: Results suggest that more physically active adolescents have a better CRF profile. The findings suggest that PA is important to adolescents' health status and it should be encouraged since childhood. Clinical practice will benefit from the use of PAI, ISWT and HR findings, allowing physiotherapists to use it for prescribing exercise.

palavras-chave

Adolescentes; Saudável; Condição Cardiorrespiratória; Índice de Atividade Física; Teste de Marcha com Carga Progressiva;

resumo

Introdução: Atualmente, menos de metade dos adolescentes cumpre os níveis diários recomendados de atividade física (AF). Sabe-se que níveis de AF mais elevados implicam melhor condição cardiorrespiratória (CCR) pelo que, um perfil da CCR pode contribuir para identificar a população-alvo para prevenção de doenças cardiovasculares e de promoção da saúde. Assim, o objetivo do estudo foi explorar a relação entre a AF e a CCR em adolescentes saudáveis.

Metodologia: Realizou-se um estudo exploratório transversal com adolescentes (12-18 anos). Recolheram-se dados sociodemográficos e antropométricos através de um questionário. A AF foi avaliada com o índice de atividade física (IAF) e as medidas da CCR incluíram a avaliação da função pulmonar (FP) pela espirometria e da tolerância ao exercício pelo teste de marcha com carga progressiva (TMCP). Dividiu-se a amostra em 2 grupos: 1 (sedentários, pouco e moderadamente ativos); 2 (vigorosamente ativos (VA)) de acordo com o IAF. A estatística descritiva permitiu caracterizar a amostra. Foram utilizados testes-t de amostras independentes para verificar diferenças entre grupos e regressões logísticas simples para identificar os preditores de ser VA.

Resultados: O estudo incluiu 115 adolescentes (14.63±1.70 anos; 56.52% género feminino) com índice de massa corporal =21.19±3.14 $Kg.m^{-2}$ e FP (volume expiratório forçado no primeiro segundo (VEMS)=105.58±12.73% do previsto) normais. Houve diferenças significativas entre grupos na altura (G1–163.44±8.01; G2–167±8.65; p=0.024), FP (VEMS/ capacidade vital forçada (CVF); G1–97.58±10.66; G2–94.04±8.04; p=0.049), distância percorrida no TMCP (G1–1089.81±214.04; G2–1173.60±191.86; p=0.038); frequência cardíaca (FC) basal (G1–84.61±13.68; G2–79.23±13.81; p=0.038), FC após o melhor TMCP (G1–124.71±37.57; G2–133.54±33.61; p=0.041) e percentagem da FC máxima (G1–63.09±19.03; G2–67.53±17.08; p=0.043). A altura (OR–1.054; 95%IC 1.006-1.104), distância percorrida no TMCP (OR–1.002; 95%IC 1-1.004) e a FC basal (OR–0.971; 95%IC 0.945-0.999) demonstraram ser preditores de ser VA.

Conclusões: Os resultados sugerem que adolescentes mais ativos têm melhor CCR e perfil cardiovascular. A AF é um fator importante para o estado de saúde dos adolescentes e deverá ser encorajada desde a infância. Na prática clínica, os fisioterapeutas poderão utilizar os dados da IAF, do TMCP e da FC para prescrever exercício.

Abbreviations

ACSM	American College of Sports Medicine
BMI	Body Mass Index
CRF	Cardiorespiratory Fitness
FEV_1	Forced expiratory volume in one second
FVC	Forced Vital Capacity
HR	Heart Rate
ISWT	Incremental Shuttle Walking Test
LF	Lung Function
MVPA	Moderate to Vigorous Physical Activity
PA	Physical Activity
PAI	Physical Activity Index
VO_{2max}	Maximal oxygen consumption in one minute
WHO	World Health Organization

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Background

Physical activity (PA) for adolescents and young people between 5 and 17 years old includes playing, sports, transportation, recreation, physical education or planned exercise, in the context of family, school and community activities (WHO, 2010). The World Health Organization (WHO) recommends at least 60 min of daily moderate- to vigorous-intensity PA (MVPA), preferentially aerobic exercises, in order to improve cardiorespiratory and muscular fitness (WHO, 2010). Aerobic training, defined as any activity that uses large muscle groups that can be maintained continuously and is rhythmic in nature, has effects on lung function (LF) depending on the intensity and duration (Chaitra, Narahare, Puranik, & Maitri, 2011).

Physical activity is the principal modifiable determinant of cardiorespiratory fitness (CRF) and it can be improved through aerobic training (Ruiz et al., 2015). Cardiorespiratory fitness is related to the "ability to perform large muscle, dynamic, moderate-to-high intensity exercise for prolonged periods" (American College of Sports Medicine (ACSM), 2009). Its assessment is considered of great importance in clinical practice for adult patients with neuromusculoskeletal, cardiac and respiratory diseases, as it provides strong and independent prognostic information about the overall risk of morbidity and mortality (Berntsen & Nystad, 2008). However, to date, the literature of CRF in paediatric population, as well as its relation with PA, is limited (Berntsen & Nystad, 2008; Wells & Norris, 2009).

Aerobic training has shown to improve the blood lipid profile, body fatness and other cardiometabolic risk factors in youth (Ruiz et al., 2015). Therefore, it is generally accepted that people with higher levels of PA tend to have higher levels of CRF and that PA can improve it, reducing morbidity and mortality from numerous chronic illnesses (Chaitra et al., 2011). Reduced PA and low CRF are accepted as important causes of morbidity and mortality creating impacts in airways and LF in healthy adolescents (Chaitra et al., 2011; Nader, Bradley, &

Mcritchie, 2008; Nourry et al., 2005; Rosenkranz, Rosenkranz, Hastmann, & Harms, 2012; Rosenkranz, Swain, Rosenkranz, Beckman, & Harms, 2011).

Although well described among other age groups, there is actually a lack of knowledge concerning the association between PA and LF (Berntsen & Nystad, 2008; Lobelo, Pate, Dowda, Liese, & Ruiz, 2009) as well as correlations between a sedentary lifestyle and health outcomes, such as respiratory related diseases in adolescents (Berntsen & Nystad, 2008). Additionally, it is known that less than half of the adolescents reach recommended levels of PA (Dumith et al., 2010). Population surveys show that approximately 80% of adolescents spend at least 30 min/day performing PA and about two-thirds of boys and one-quarter of girls report performing 20 min of MVPA three times per week, and yet international recommendations are still not being met. Additionally, the time spent in MVPA tends to decrease as age increases (Mota & Esculas, 2002; Nader et al., 2008). A health-related CRF criterion value for adolescents can be useful to identify the target population for primary cardiovascular disease prevention as well as for health promotion interventions (Lobelo et al., 2009). A better knowledge of this relationship would allow physiotherapists to prescribe exercise to adolescents with the tests used in clinical practice.

Therefore, the aim of this study was to explore the relationship between PA levels and cardiorespiratory factors in healthy adolescents.

Methods

Study Design and Ethics

This was a cross-sectional exploratory study (Fortin, 2006) conducted with a convenient sample of healthy adolescents aged between 12 and 18 years old. This study was part of a broader study to establish paediatric reference values of physical condition and respiratory sounds. The study received full approval from the Ethics Committee of the Research Unit of Health Sciences at the School of Nursing in Coimbra, Portugal (Annex 1).

Recruitment and participants

A school in Aveiro was contacted by the researcher and a meeting arranged with the school headmaster to provide full details about the study and collect a signed authorisation to conduct the study. Then, the school headmaster identified the heads of eligible classes and provided information about the study. These teachers recommended the physical education classes to collect data. Therefore, the researcher arranged a second meeting with the physical education teachers to explain the study and clarify doubts. The study was then presented to eligible adolescents and a written information sheet about the objectives and description of the study was given to each adolescent and to their legal guardian.

Adolescents were considered eligible if they were healthy adolescents aged between 12 and 18 years old, without signs and symptoms of cognitive impairment, musculoskeletal or cardio-respiratory disorders that could compromise their ability to perform the physical tests. Patients were excluded if they had a respiratory infection in the last month, any chronic pulmonary disease or showed any sign of substance abuse such as drugs or alcohol.

Data Collection

Data collection occurred between September 2014 and March 2015. Signed informed consents were previously obtained from each adolescent and from their legal guardian who authorized their participation in the study by signing an informed consent (Oliveira & Pereira, 2006). The protocol was performed in a single session of approximately 90 minutes.

Socio-demographic data, including gender, date of birth and educational level; and body composition data, including weight and height to calculate body mass index (BMI), were initially collected.

The Physical Activity Index (PAI) is a non-expensive, fast to fill questionnaire commonly used to characterize the level of perceived PA. This questionnaire has

five questions, with four options each, concerning the frequency, intensity and type of PA. PAI is scored between 1 to 4 points, having a maximum score of 20 and minimum score of 5 points. The sum of the scores of each question classifies subjects in one of four possible categories: sedentary (score=5); low active (score=6-10); moderately active (score=11-15) and vigorously active (score≥16) concerning their reported PA (Ledent et al., 1997). PAI has shown excellent test-retest reliability (Intraclass Correlation Coefficient (ICC)=0.92 to 0.96) and good internal consistency (α=0.87), in adolescents between 13 and 20 years old (Mota & Esculas, 2002). This index was also used in other investigations to determine if young adult obesity is related to the level of PA in childhood and adolescence (Telama et al., 2005). In the present study, the sample was divided in two groups: G1 – sedentary, low active and moderately active groups; G2 – vigorously active group. This division was performed due to the unevenness of adolescents in PAI categories.

Cardiorespiratory fitness measures included LF measured with spirometry and exercise tolerance measured with Incremental Shuttle Walking Test (ISWT).

Spirometry was performed according to the American Thoracic Society and European Respiratory Society guidelines (Miller et al., 2005), with a portable spirometer (MicroLab 3500, CareFusion, Kent, UK). Each adolescent was placed in a sited position and, after the researcher's explanation about the spirometry manouver, was encouraged to inhale rapidly and completely, seal the lips around the mouthpiece and blast the air as fast as possible until fully exhale. During the manoeuvre, the researcher encouraged each adolescent with standard phrases such as "keep going". Attention was paid to signs and symptoms of dizziness, and the test was immediately interrupted if needed. Although spirometry does not lead directly to an etiological diagnosis, its application is recommended to screen individuals at risk of having pulmonary disease. Thus, it becomes essential to use spirometry in LF evaluation (Miller et al., 2005).

The ISWT is a simple, easy to administer and non-expensive test commonly used in clinical practice of physiotherapy, which evaluates maximal exercise capacity

based on the distance walked around a 10m course with incremental speed ordered by an audio signal, to quantify the CRF (Probst et al., 2012). It has an excellent reliability (ICC=0.88, 95% Confidence Intervals (CI) 0.83 – 0.92) in patients with chronic obstructive pulmonary disease (Singh et al., 2014). The ISWT was performed twice, for a more reliable result, due to the learning effect with a pause of at least 30 minutes between tests, allowing to return to baseline values of cardiac and respiratory parameters (Probst et al., 2012) at the end of data collection session in the school's gymnasium. To mark the trajectory, two signalling cones were placed at a distance of 10 m between them. Adolescents were instructed to go from the first mark to the other after the initial signal (four beeps), contour the cone and return after the next beep. They were also informed that, for each minute, the time to complete the itinerary was going to decrease. The test was over when the adolescent could not reach the next mark before two consecutive beeps, felt chest pain, dizziness, dyspnoea or presented a heart rate (HR) above the maximum predicted for their age (Probst et al., 2012). Heart and respiratory rate, oxygen saturation, blood pressure, dyspnoea and fatigue were measured at baseline and immediately after the end of the test. This test is a guide for exercise prescription during rehabilitation (Probst et al., 2012). It has been used as a predictor of mortality, morbidity and as a predictor of exacerbation in patients with chronic respiratory and other diseases, as well as for assessing benefits of interventions (Dourado, Guerra, Tanni, Antunes & Godoy, 2013; Probst et al., 2011). Previous studies evaluating the ISWT in healthy subjects have shown that it is valid and responsive and appears to induce a maximum exercise response, which is appropriate for assessing functional capacity (Dourado et al., 2013). The test was also applied in pediatric populations with asthma and cystic fibrosis to assess their physical performance (Ahmaidi, Varray, Savy-Pacaux, & Prefaut, 1993; Pouessel et al., 2003; Selvadurai et al., 2003).

The Modified Borg Scale was used to evaluate the perceived dyspnoea and fatigue before and immediately after ISWT tests. This is a non-expensive, fast way to assess perceived symptoms showing good correlation with the maximal oxygen consumption predicted in one minute (VO_{2max}) (Borg, 1982). This is a 10-point

scale, including written indicators of severity to anchor specific numbers on the scale (Borg, 1998).

Data Analysis

Descriptive statistics were applied to characterise the entire sample (i.e., socio-demographic and body composition, PA and CRF parameters (LF and exercise tolerance)). PA data was grouped according to their level of perceived PA. The normality of data distribution was checked with Kolmogorov-Smirnov tests.

Inferential statistics were calculated using independent sample t-tests to assess differences between groups (G1 and G2) related to age, BMI, LF parameters (i.e., forced expiratory volume in the first second (FEV_1), forced vital capacity (FVC), FEV_1/FVC), CRF parameters (ISWT distance, ISWT level, and VO_{2max}, and HR at rest, HR after the best ISWT and the % of the maximum HR achieved), dyspnoea and fatigue. Simple logistic regressions were performed to identify the predictors of being vigorously active (G2).

The statistical analysis was performed using the statistical package SPSS version 17.0 (SPSS Inc., Chicago, Illinois, USA). The level of significance was set at $p<0.05$.

Results

Characteristics of the sample

One hundred and fifteen adolescents were included in the study (n=65; 56.52% female). Adolescents' mean age was 14.63±1.70 years old and presented a normal body composition (BMI=21.19±3.14 $Kg.m^{-2}$) and LF (FEV_1=105.58±12.73% of predicted). According to PAI classification, adolescents were sedentary (n=7; 6.09%), low active (n=18; 15.65%), moderately active (n=34; 29.57%) and vigorously active (n=56; 48.69%). Table 1 provides a detailed description of the sample.

Table 1 - Characteristics of the sample.

Characteristics	Total (n=115)
Age (years)	14.63±1.70
Weight (Kg)	57.78±10.42
Height (cm)	165.17±8.49
BMI (Kg.m^{-2})	21.19±3.14
Lung Function	
FEV_1 % predicted	105.58±12.73
FVC % predicted	98.97±11.97
FEV_1/FVC %	95.87±9.61
PAI total score	12.01±3.61
PAI total score according to the classification	
G1: sedentary, low and moderately active	9.10±2.49
G2: vigorously active	15.07±1.37
ISWT	
Distance	1119.37±220.74
Level	13.06±1.49
VO_{2max} predicted	45.64±8.39
$HR_{at\ rest}$	81.99±13.95
HR_{post}	129.01±35.82
$\%HR_{max}$	65.25±18.16
Dyspnoea	6.63±8.01
Fatigue	6.59±2.32

Data is expressed as mean ± standard deviation.

Abbreviations - BMI: body mass index; PAI: physical activity Index; FEV_1: forced expiratory volume in the first second; FVC: forced vital capacity; ISWT: incremental shuttle walking test; VO_{2max}: maximal oxygen consumption predicted in one minute; HR: heart rate *:p<0.05.

Comparison between groups

Significant differences were found between G1 and G2 for height (G1 – 163.44±8.01cm; G2 – 167±8.65cm; p=0.024), LF (FEV_1/FVC; G1 – 97.58±10.66; G2 – 94.04±8.04; p=0.049), ISWT distance (G1 – 1089.81±214.04m; G2 – 1173.60±191.86m; p=0.038); HR at rest (G1 – 84.61±13.68bpm; G2 – 79.23±13.81bpm; p=0.038), HR after the best ISWT (G1 – 124.71±37.57bpm; G2 – 133.54±33.61bpm; p=0.041) and percentage of the maximal HR (G1 – 63.09±19.03%; G2 – 67.53±17.08%; p=0.043) (Table 2).

Table 2 - Differences between groups in sample characteristics

GROUPS	G1 (n=59)	G2 (n=56)	p-value
Age (years)	14.75±1.99	14.50±1.35	0.442
Gender			
Male	23 (38.98%)	27 (48.21%)	0.209
Female	36 (61.02%)	29 (51.79%)	
Height (cm)	163.44±8.01	167±8.65	0.024*
Weight (Kg)	56.94±10.71	59.67±10.12	
BMI ($Kg.m^{-2}$)	21.43±3.67	20.92±2.47	0.384
Lung Function			
FEV_1 % predicted	105.95±11.98	105.17±13.60	0.746
FVC % predicted	98.85±10.91	99.11±13.12	0.908
FEV_1/FVC	97.58±10.66	94.04±8.04	0.049*
ISWT			
Distance (m)	1089.81±214.04	1173.60±191.86	0.038*
Level	12.96±1.50	13.16±1.49	0.488
VO_{2max} predicted	44.91±8.60	46.37±8.18	0.362
$HR_{at\ rest}$	84.61±13.68	79.23±13.81	0.038*
HR_{post}	124.71±37.57	133.54±33.61	0.041*
$\%HR_{max}$	63.09±19.03	67.53±17.08	0.043*
Dyspnoea	7.54±10.91	5.66±2.35	0.236
Fatigue	6.39±2.33	6.80±2.30	0.341

Data is expressed as mean ± standard deviation unless otherwise indicated. P-value concerns significance of the test result.

Abbreviations - BMI: body mass index; PAI: physical activity Index; FEV_1: forced expiratory volume in the first second; FVC: forced vital capacity; ISWT: incremental shuttle walking test; VO_{2max}: maximal oxygen consumption predicted in one minute; HR: heart rate * $p<0.05$.

Predictors of being vigorously active

Results of simple logistic regressions are presented in Table 3. Height (OR 1.054; 95%CI 1.006-1.104), ISWT distance (OR 1.002; 95%CI 1.000-1.004) and HR at rest (OR 0.971; 95%CI 0.945-0.999) were predictors of being vigorously active (Table 3). For example, this implies that an increase of 1 cm in height; 1 m in ISWT distance and 1bpm in HR rest yields an increase of 5.9%, 5.5% and 5.0% respectively in the odds of adolescents being vigorously active.

Table 3 - Predictors of being vigorously active using simple logistic regressions.

	PAI Classification		
	OR (95% CI)	**p-value**	**R^2**
Height (cm)	1.054 (1.006-1.104)	0.027*	5.9%
Lung Function			
FEV_1/FVC	0.961 (0.923-1.000)	0.051	4.6%
ISWT			
Distance	1.002 (1.000-1.004)	0.042*	5.5%
$HR_{at\ rest}$	0.971 (0.945-0.999)	0.042*	5.0%
HR_{post}	1.007 (0.997-1.018)	0.187	2.0%
$\%HR_{max}$	1.014 (0.993-1.035)	0.190	2.0%

n = 115. P-value concerns significance of the test result.

Abbreviations - 95% CI: 95% confidence interval; PAI: physical activity Index; OR: odds ratio; R^2: Nagelkerke R Square; FEV_1: forced expiratory volume in the first second; FVC: forced vital capacity; ISWT: incremental shuttle walking test; HR: heart rate * $p<0.05$.

Discussion

This study explored the relationships between PA levels and cardiorespiratory factors in healthy adolescents between 12 and 18 years old. It was found that vigorously active adolescents were significantly taller, had a lower FEV_1/FVC ratio, walked a longer distance in the ISWT, had a lower HR at rest, a higher post-test HR and reached a higher percentage of the maximal HR than the sedentary, low active and moderately active adolescents.

Differences in body composition showed that adolescents with higher levels of PA were taller than the adolescents with lower levels of PA. One study conducted in Oporto, Portugal showed significant correlations between adolescents' height and different levels of habitual PA (Silva, 2012). A large study (n=2537), conducted with Scandinavian children (9 and 10 years old) evaluated height but compared with CRF instead of PA, and significant differences, in which taller children had higher levels of CRF were also found (Berntsen & Nystad, 2008). The same study also found that children with higher PA level presented significant lower BMI (Berntsen & Nystad, 2008). Other study have shown that body composition, evaluated by waist circumference, has positive correlations to the time spent doing

MVPA as well as with VO_{2max} in children (Hussey, Bell, Bennett, O'Dwyer, & Gormley, 2007) and with CRF (Silva, 2012). There is literature that corroborates these implications of body composition and its inversely association with CRF and cardiovascular disease (Lobelo et al., 2009; Silva, 2012). Based on the results found in this study and the literature, it cannot be inferred if height predicts the CRF profile, or if CRF profiles predict height, and the association with propensity for PA. Should physiotherapists pay closer attention to shorter adolescents and consider them as a target population? Future studies are needed to explore these findings and hypotheses.

Significant differences in FEV_1/FVC ratio between groups were observed, which may be explained by the higher CRF of adolescents with better physical condition and a normal FVC according to their age and health status (Miller et al., 2005). Although not statistically significant, FEV_1/FVC has shown a tendency to be a predictor of being vigorously active (p-value=0.051). It would be possible that, with a larger sample, this result would gain significance as a predictor. The lack of significant differences may be associated with the group division. Groups based on the PAI scores were composed, as distribution between the different PA levels was uneven however, by pooling data, differences may not have been observed. Studies with larger samples in each PA level to explore these data are therefore needed. Other study also showed that FEV_1 and FVC tended to increase with increasing level of PA, height, age, BMI among others in children (Berntsen & Nystad, 2008). The higher level of LF observed in the vigorously active adolescents in this study support their better CRF. In fact, a study conducted in India compared adolescents (12 to 16 years old; n=200) from a residential school with regular PA and nutrition controlled by nutritionists, with non-residential adolescents. This study found that residential adolescents, with higher levels of PA had also higher values of VO_{2max} and FEV_1 (Khodnapur, Dhanakshirur, & Aithala, 2012). This indicates that adolescents with higher levels of PA also have a better CRF (Khodnapur et al., 2012), corroborating the findings of this study. Spirometry findings may be interesting to physiotherapists as they give them an idea of the CRF profile and is an important element to aerobic exercise prescription.

Longer distances in ISWT were also characteristic in vigorously active adolescents, indicating a better CRF. Simultaneously, adolescents showed significant differences in HR at rest, reinforcing the idea of less cardiovascular risk with the increase of CRF. A large study conducted in Spain with 4902 adolescents aged 12 to 19 years old, also observed that adolescents who had a normal CRF for their age, according to FITNESSGRAM (Cureton & Warren, 1990; Research, 2004) had a significantly lower CVD risk score compared with those who did not meet the standards (Lobelo et al., 2009). These results suggest that more active adolescents tend to have a better CRF and consequently, cardiovascular profiles. Cardiorespiratory fitness is representative of the health status and general capacity of cardiovascular and respiratory systems. It also describes the ability to carry out prolonged exercise (Taylor, Buskirk, & Henschel, 1955). The standard indicator of CRF is the maximal oxygen uptake. In this study, no significant differences were found in VO_{2max} predicted, yet, the ISWT distance achieved by the adolescents, a proportional measure, was significant higher in more active adolescents as found in other study (Silva, 2012). To the clinical practice, it may be inferred that by increasing PA levels, adolescents will show a better CRF and so, will have better cardiovascular profile as well.

A study conducted with Portuguese adolescents found that higher levels of MVPA are associated with improved CRF. The same study found significant differences between gender in which boys had an increased odds ratio of being fit and were significantly more active then girls and, therefore, had higher levels of CRF (Silva, 2012). The present study found no differences between gender possibly due to the sample size (n=115; 56.52% female) when compared to the study of Silva (2012) (n=310; 59.03% female). There are also no significant differences in percentage of adolescents of each gender as well as the age of the adolescents included which was 12 to 18 in the present study and 11 to 18 in the study referred.

This study showed that adolescents with lower HR at rest presented higher PA levels. PA, especially aerobic exercise, is the main modifiable determinant of CRF, being well described, as a strong, independent predictor of morbidity and mortality (Lobelo et al., 2009; Ruiz et al., 2015). These results were expected as it is well

described in the literature that higher levels of PA (as seen in athletes) lead to lower HR at rest (Drezner et al., 2013). Higher levels of CRF are associated with healthier cardiovascular profiles and with a decrease of lipid disorders, high blood pressure, insulin resistance, and risk of myocardial infarction later in life risk, among others (Lobelo et al., 2009; Peterhans, Worth, & Woll, 2013; Ruiz et al., 2015). Studies support that the CRF profile is a predictor of the cardiovascular profile and, as mentioned above, the level of PA is a predictor of the level of CRF (Lobelo et al., 2009; Peterhans et al., 2013; Ruiz et al., 2015). The level of PA may enable a better understanding of the cardiovascular status.

Limitations of the study

Some limitations of this study need to be acknowledged. Due to the small and unbalanced sample, data was pooled based on the PA scores into two groups: n=59 (51.3%) in G1 – sedentary, low active and moderately active; n=56 (48.7%) in G2 – vigorously active, which may have limited the results. The similarity of PAI scores between groups (from 11 to 15 in G1; and from 16 to 20 in G2) may have hindered the results. Future studies could include 3 equitable groups (1st – sedentary and low active; 2nd – moderately active; 3rd – vigorously active) to strengthen and differentiate results. Also, PAI is a subjective instrument to assess PA. By using an objective measure as accelerometry, simultaneously, results could be strengthened. Another limitation is the lack of data on lower limb and stride length that would enhance the understanding on the influence of height in PA and CRF.

Additionally, data collection was performed in the school, during class, in a single session to decrease the time spend out of class. Due to this restriction, adolescents had to perform both ISWT test with an interval of only 30 minutes, which may not have been enough to return to baseline values. In future studies, the assessment could be performed in 2 sessions with a difference of 24 hours and prevent this possible tiredness. Furthermore, data collection was performed by four investigators and so, some bias could have occurred however,

investigators were trained and performed the assessment according to the protocols previously described in the literature to minimize this possible bias.

Conclusion

Results suggest that more physically active adolescents present better CRF profile. The findings suggest that PA is important to adolescents' health status and it should be encouraged since childhood. Clinical practice will benefit from the use of PAI, ISWT and HR findings, allowing physiotherapists to use it for prescribing exercise in their interventions.

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APPENDIX I

Folha de Informação ao Encarregado de Educação

A estudante Sara Quina**,** a frequentar o Mestrado em Fisioterapia da Escola Superior de Saúde da Universidade de Aveiro, sob a orientação científica da Professora Doutora Alda Marques, vêm por este meio solicitar-lhe a autorização para a participação do seu educando no estudo intitulado: "Valores do teste de marcha com carga progressiva e sua relação com a atividade física e função pulmonar na população pediátrica saudável".

Mas, antes de decidir, é importante que compreenda porque é que a investigação está a ser realizada e o que é que a mesma envolve. Por favor, leia a informação com atenção e discuta a participação do seu educando, com o próprio e com outros se assim o entender. Se houver algo que não esteja claro para si ou necessitar de informação adicional, por favor não hesite em contactar a estudante ou a sua orientadora (contactos no final deste documento).

Muito obrigado desde já por ler a informação.

Qual é o propósito do estudo?

Este estudo visa estabelecer valores de referência para o teste de marcha com carga progressiva modificado em crianças saudáveis (10-18 anos). Este teste permite uma avaliação objetiva e segura da condição cardiorrespiratória das crianças sendo por isso largamente utilizado pelos fisioterapeutas para prescrever exercício físico em crianças com várias patologias como por exemplo, com asma e fibrose cística. No entanto, ainda não se encontram estabelecidos valores de referência para crianças saudáveis que possam ser usados para comparar com os valores de uma criança com determinada patologia. Para que seja possível determinar estes valores de referência, vimos então solicitar-lhe autorização para que o seu educando participe neste estudo que será realizado na instituição de educação por ele frequentada.

Porque foi o meu educando escolhido?

O seu educando foi escolhido porque se encontra a frequentar uma escola do distrito de Aveiro que deu permissão institucional para a realização do estudo e porque o seu educando não apresenta problemas respiratórios significativos.

Tenho de aceitar a participação do meu educando?

A decisão de autorizar ou não a participação do seu educando é completamente sua. Se decidir autorizar vai ser-lhe pedido que assine dois formulários de consentimento informado, um para si e outro para a estudante de mestrado. No entanto, é totalmente livre de desistir a qualquer momento, sem que para tal tenha de dar qualquer justificação. A decisão de desistir ou de não

participar, não afetará a qualidade dos serviços de educação ou quaisquer outros prestados ao seu educando agora ou no futuro.

O que acontecerá se autorizar a participação do meu educando?

Se decidir participar vai ser-lhe pedido que preencha o documento anexo a esta folha (que procura recolher informação breve sobre a condição de saúde e medicação habitualmente utilizada pelo seu educando) e que o entregue, bem como ao consentimento informado, ao docente que entrou em contacto consigo.

Após receber o consentimento informado devidamente assinado, a estudante dirigir-se-á à instituição de educação do seu educando e procederá à recolha de dados. Ser-lhe-á medido o peso e a altura, e realizar-se-á um teste muito simples para avaliar a função respiratória, com um aparelho designado de espirómetro. Este teste consiste em soprar todo o ar dos pulmões para um bocal, com a maior força possível. Ser-lhe-á também pedido que responda a um questionário de atividade física para avaliar as atividades físicas que realiza dentro e fora da instituição.

De seguida, será medida a força muscular dos membros inferiores com um aparelho chamado dinamómetro, através de um teste muito simples que consiste a partir da posição de sentado, esticar o joelho com a máxima força possível contra uma resistência dada pela estudante.

Seguidamente, será realizado o teste de marcha com carga progressiva (modificado). Durante o teste será pedido ao seu educando que caminhe rapidamente, em velocidades crescentes, num percurso de 10 m delimitados por 2 cones (estando um cone em cada extremidade do percurso), que devem ser contornados pelo individuo. A saturação periférica de oxigênio (SpO_2) e a frequência cardíaca serão avaliados antes e após a realização do teste através de um oxímetro de pulso, para garantir que o teste decorre em total segurança. Após trinta minutos de repouso, repetir-se-á o teste. A aplicação do protocolo terá a duração de aproximadamente 60 minutos.

Nenhum destes testes provoca qualquer desconforto e serão realizados em horários compatíveis com as atividades educacionais, de forma a não afetar a o programa letivo de atividades.

Quais são os efeitos secundários dos procedimentos do estudo?

Não existem efeitos secundários de participar no estudo.

Quais são as possíveis desvantagens e riscos se resolver autorizar a participação do meu educando?

Não existem quaisquer desvantagens ou riscos de participar no estudo.

Quais são os possíveis benefícios se eu resolver autorizar a participação do meu educando?

Não existem benefícios diretos de participar no estudo. No entanto, todas as medidas recolhidas na avaliação ser-lhe-ão comunicadas para que fique informado acerca da condição de saúde e física do seu educando. Para além disso, a informação obtida neste estudo poderá ajudar a

desenvolver valores de referência para um teste largamente utilizado na fisioterapia, permitindo uma melhor avaliação e monitorização de crianças e prescrever exercício adequado em caso de patologia.

A participação será confidencial?

Toda a informação recolhida no decurso do estudo será mantida estritamente confidencial. Os dados recolhidos serão salvaguardados com um código, para que ninguém os possa identificar. Apenas a estudante responsável pelo projeto e a sua orientadora terão acesso aos dados.

O que acontecerá aos resultados do estudo?

Os resultados do estudo serão analisados e incorporados em dissertações de Mestrado e alguns serão publicados em Jornais e/ou conferências de finalidade científica. No entanto, em nenhum momento o seu educando será identificado. Se pretender obter uma cópia de qualquer relatório ou publicação, por favor solicite-o enviando *e-mail* para a aluna responsável pelo projeto.

Contacto para mais informações sobre o estudo

Se pretender obter mais informações sobre o estudo, pode telefonar ou escrever para:

Sara Quina ou Alda Marques
Escola Superior de Saúde da Universidade de Aveiro,
Universidade de Aveiro,
Campus de Santiago,
Edifício III, 3810-193, Aveiro
Telefone: 234 247 113 ou 234 372 462
e-mail: saraquina@ua.pt*; amarques@ua.pt*.

Muito obrigado por ter lido esta informação.

APPENDIX II

Consentimento Informado

Título do Projeto: Valores do teste de marcha com carga progressiva e sua relação com a atividade física e função pulmonar na população pediátrica saudável

Orientadora: Prof. Doutora Alda Sofia Pires de Dias Marques
Estudante de Mestrado: Sara Daniela Quina Rodrigues

Por favor leia e assinale com uma cruz (X) os quadrados seguintes.

1. Eu confirmo que percebi a informação que me foi dada e tive a oportunidade de questionar e de me esclarecer. ☐
2. Eu percebo a participação do meu encarregando é voluntária e que ele é livre de desistir, em qualquer altura, sem dar nenhuma explicação, sem que isso afete qualquer serviço de saúde que lhe é prestado. ☐
3. Eu compreendo que os dados recolhidos durante a investigação são confidenciais e que só os investigadores responsáveis pelo projeto têm acesso a eles. E dou portanto, autorização para que os mesmos tenham acesso a esta informação. ☐
4. Eu compreendo que os resultados do estudo serão publicados numa dissertação de mestrado e jornais e/ou conferências de finalidade científica sem que haja qualquer quebra de confidencialidade e anonimato. E dou portanto, autorização para a utilização dos dados para esses fins. ☐
5. Eu confirmo que o meu encarregando foi questionado acerca da sua vontade em participar no estudo e que nenhuma avaliação foi realizada contra a sua vontade, sendo assim respeitada a sua autonomia. ☐
6. Eu concordo então que o meu educando participe no estudo. ☐

Nome do Participante	Encarregado de Educação	Data	Assinatura

Investigadora	Data	Assinatura

ANNEX I

COMISSÃO DE ÉTICA

da **Unidade Investigação em Ciências da Saúde - Enfermagem** (UICISA: E)

da **Escola Superior de Enfermagem de Coimbra** (ESEnfC)

Parecer Nº P186-10/2013

Título do Projecto: Estabelecimento de valores de referência para sons pulmonares adventícios e o teste de marcha com carga progressiva modificado em crianças saudáveis e com patologia respiratória

Identificação do Proponente

Nome(s): Alda Sofia Pires de Dias Marques; Ana Luísa Araújo Oliveira; Sara Sequeira Silva

Filiação Institucional: Escola Superior de Saúde da Universidade de Aveiro

Investigador Responsável/Orientador: Profª Alda Sofia Pires de Dias Marques

Relator: José Carlos Amado Martins

Parecer

Trata-se de estudo descritivo, correlacional, tendo como objetivo principal: "estabelecer valores de referência para os sons pulmonares adventícios e para o teste de marcha com carga progressiva em crianças com patologia respiratória e saudáveis, contribuindo assim para melhor compreensão das patologias, e consequentemente, melhorar o diagnóstico, monitorização e tratamento de crianças com problemas respiratórios".

Será utilizada amostra de conveniência, com crianças (idade<18 anos), com diagnóstico de patologia respiratória pediátrica e crianças saudáveis. Os critérios de inclusão/exclusão são definidos. Colheita de dados de dezembro de 2013 a dezembro de 2016.

A caracterização decorrerá no Hospital Santa Maria (Porto), Banda Filarmónica Ovarense (Ovar), Clube do Povo de Esgueira (Aveiro) e Clínica Estrela Esteves Unipessoal (Aveiro), instituições com as quais existe protocolo de colaboração com a Universidade de Aveiro e que já aprovaram o estudo, sendo apresentados comprovativos.

São definidas as medidas e testes a utilizar que têm um carácter não invasivo.

É garantida a confidencialidade e o anonimato da informação em todo o processo de recolha e análise. Será solicitado o consentimento do responsável legal de cada criança e à própria criança, em função do seu grau de maturidade. São apresentados os documentos para informação e obtenção do consentimento na forma escrita, que cumprem os requisitos éticos.

Não são previstos desvantagens ou riscos para os participantes.

Tendo em consideração o exposto, é entendimento desta Comissão que, em termos éticos, nada há a opor ao desenvolvimento da investigação.

O relator: José Carlos Amado Martins

Data: 20/11/2013 O Presidente da Comissão de Ética:

FCT Fundação para a Ciência e a Tecnologia

A Pedido do Senhor Presidente da
Comissão de Ética da UICISA: E

Informamos que se juntou à equipa de investigadores do projeto **Estabelecimento de valores de referência para sons pulmonares adventícios e o teste de marcha com carga progressiva modificado em crianças saudáveis e com patologia respiratória**, as Senhoras Sara Daniela Quina Rodrigues e Maria Manuel Almeida Regêncio.

Com os melhores cumprimentos

Cristina Louçano, Lic.
Administrative Assistant
Unidade de Investigação em Ciências da Saúde: Enfermagem
| Escola Superior de Enfermagem de Coimbra
| Polo C – Rua José Alberto Reis – Coimbra |
| investiga@esenfc.pt | +351 239 487 217 |

ANNEX II

Autorização Institucional

Eu, Carlos Alberto Pinheiro Lopes

responsável pela instituição Agrupamento de Escolas de Oliveirinha declaro que fui informado dos objetivos do estudo científico intitulado: "Valores do teste de marcha com carga progressiva e sua relação com a atividade física e função pulmonar na população pediátrica saudável", e concordo em autorizar a execução da mesma nesta instituição. Caso necessário, a qualquer momento como instituição CO-PARTICIPNATE desta investigação, poderemos revogar esta autorização, se comprovada atividades que causem algum prejuízo à instituição ou ainda, a qualquer dado que comprometa o sigilo da participação dos integrantes desta instituição. Declaro também, que não recebemos qualquer pagamento por esta autorização bem como os participantes também não receberão qualquer tipo de pagamento.

Carlos Alberto Pinheiro Lopes	02-09-2024	
Representante da Instituição	Data	Assinatura
Sara Daniela Duarte Rodrigues	02-09-2024	
Investigadora	Data	Assinatura

ANNEX III

Telama-Potuguês

Elaborado e validado por Ledent Cloes & Piéron (1997)

O presente questionário pretende identificar o nível de actividade física dos jovens, por isso, são-te postas questões sobre os teus hábitos de actividade física, mas não te preocupes em acertar ou errar, porque não existem respostas certas ou erradas. Procura ser sincero nas tuas respostas e, desde já, agradeço a tua colaboração.

Q.1. Fazes parte de actividades desportivas extra-escola (num clube ou noutro sítio)?

(1) Nunca	[ ]	(2) Menos de uma vez por semana	[ ]
(3) Uma vez por vez por semana	[ ]	(4) Quase todos os dias	[ ]

Q.2. Participas em actividades de lazer (ocupação do tempo livre) sem integrares um clube?

(1) Nunca	[ ]	(2) Menos de uma vez por semana	[ ]
(3) Uma vez por vez por semana	[ ]	(4) Quase todos os dias	[ ]

Q.3. Para além das horas lectivas, quantas vezes praticas desportos durante, pelo menos, vinte minutos?

(1) Nunca	[ ]	(2) Pelo menos uma vez por mês	[ ]
(3) Entre uma vez por mês e uma vez por semana	[ ]	(4) Entre 2 a 3 vezes por semana	[ ]
(5) Entre 4 a 6 vezes por semana	[ ]	(6) Todos os dias	[ ]

Q.4. Fora do tempo escolar, quanto tempo por semana dedicas à prática de actividades desportivas ao ponto de ficares ofegante (respirar depressa e com dificuldade) ou transpirando?

(1) Nunca	[ ]	(2) Entre meia-hora e uma hora	[ ]
(3) Entre 2 a 3 horas	[ ]	(4) Entre 4 a 6 horas	[ ]
(5) Sete ou mais horas	[ ]		

Q.5. Participas em competições desportivas?

(1) Nunca participei	[ ]	(2) Não participo, mas já participei	[ ]
(3) Sim, a nível interescolar	[ ]	(4) Sim, ao nível de um clube	[ ]
(5) Sim, a nível nacional e/ou internacional	[ ]		