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Lung Function in Adults: Relationship between Time Practice of Physical Activity and Nutritional Status

Paulo Roberto da SILVA[1], Wagner Luis RIPKA[2], Leandra ULBRICHT[1]
[1]Federal University of Technology - Paraná, Graduate Program in Biomedical Engineering, Curitiba, BRAZIL
[2]Federal University of Technology - Paraná, Graduate Program in Electrical Engineering and Computer Science, Curitiba, BRAZIL
Email: profepaulosilva@gmail.com, ripka.w@gmail.com, prof.leandra@gmail.com

Abstract

Background: Much is said about the importance of physical activity to improve lung function in people with some kind of respiratory disease, however, there are few studies comparing long-term impact of physical activity on lung function among regular physical activity practitioners without complaints or history of lung disease. The objective of this study was to observe the relationship between time of physical activity, nutritional status and lung function variables in Brazilian adults. Methods: a descriptive exploratory study was conducted with 799 individuals (268 men and 531 women) aged between 18 and 59 years old who participate in physical activity programs offered by a municipal sports and recreation department. The volunteers were subjected to forced spirometry test to collect data concerning: values of Forced Vital Capacity (FVC), Forced Expiratory Volume on the first second (FEV1) and Peak Expiratory Flow (PEF). Additionally, body mass and height were identified using digital scale with coupled stadiometer to calculate the body mass index (BMI= kg/m^2). This index was used to grade individuals into three categories: normal nutritional status, overweight or obese. A questionnaire on regular physical activity practice time was also applied. Data were processed adopting a 5% significance level. Results: There was significant association between nutritional status and pulmonary function test (x^2= 16.39; p= 0.003) for men. An association between increased BMI and the risk of restrictive lung disease was confirmed. In women the figures were x^2= 3.41 (p= 0.492). Additionally, there was no significant association between pulmonary function test and time of physical activity in either gender. Conclusion: In this study, the nutritional status confirms its interference on respiratory function, even among regular practitioners of physical activity, and spirometric results suggest that long-term physical activity does not promote significant changes on lung function.

Keywords: Pulmonary function, spirometry, physical activity, FVC, FEV1, PEF

Introduction

In Brazil, prevalence of pulmonary disease is one for every nine individuals and airflow limitation caused by respiratory diseases can lead to a drop in performance during physical activities and in daily life activities, making an early detection of these conditions an important strategy for medical treatment, thus preventing the progression thereof (Burnett, Burns, Merritt, Wick, & Sharpe, 2016; Ferreira, 2012; Hwang et al., 2009; McArdle, Katch, & Katch, 2001)

A technique available to health professionals for that monitoring is spirometry, which has its importance tied to several variables of preventive and therapy respiratory health (Burnett, et al., 2016; Kubota et al., 2014; Miller et al., 2005; Teixeira et al., 2012). In fact, spirometry is considered one of the main pulmonary function tests, and it is a test of easy application and high reproducibility. For that reason, it is considered a functional test that allows from standard protocol to measure pulmonary volumes, capacities and flows, thus evaluating the existence or not of respiratory pathologies of restraining, obstructive or mixed order (Costa, 2011; Jagia & Hegde, 2014; Pereira et al., 2002; Teixeira, et al., 2012; Trindade, de Sousa, & Albuquerque, 2015)

Clinical evaluation studies on lung function have shown that people with a regular physical activity level get better results in pulmonary function tests when compared to sedentary people (Durmic et al., 2015; Humphreys, McLeod, & Ruseski, 2014; Paulo et al., 2015). Moreover, regarding nutritional status, individuals with extreme nutritional imbalance - with body mass index (BMI) indicating low weight and obesity, tend to be more prone to develop respiratory diseases when compared to those with normal BMI (Genc et al., 2014; Humphreys, et al., 2014; Liu, Roberts, Moyer-Mileur, & Samson-Fang, 2005; Paulo, et al., 2015; Thakker, 2014). Studies show that when affected by a respiratory disease the individuals need to include exercise in their routines and keep their BMI within the normal range due to its positive impact on maintenance, treatment and prevention of comorbidities (Demeyer et al., 2014; Fenger et al., 2014; Pakhale, Baron, Dent, Vandemheen, & Aaron, 2015). However, it is perceived a scarcity of studies comparing long-term impact of physical activity on lung function among practitioners of regular physical activity with no complaints or history of lung disease.

Thus, the aim of this study was to analyze the relationship between time of physical activity, nutritional status and lung function variables in Brazilian adults.

Methods

Research individuals

It was performed a descriptive exploratory study with 799 individuals of both genders aged between 18 and 59 years old. The sample was composed by practitioners in physical activity programs offered by public institutions of the city of Curitiba. Participants should have completed at least the first month of physical activities in order to be selected. Besides, the study included individuals who did not have any of the following exclusion criteria: history of respiratory, cardiovascular, or anatomical disease in the chest region; neuromuscular disease; retinal detachment; being a smoker; complaints of pain in any body part ; having undergone surgery in the last year, especially if cardiac surgery or in the thoracic region; failed to perform the proposed testing technique; individuals who have nausea, vomiting or cognitive problems that hinder understanding of any of the research details (Durmic, et al., 2015;

Kubota, et al., 2014; Løkke et al., 2013; Rodrigues et al., 2002; Spencer, Alison, & McKeough, 2007).

Anthropometric assessment and physical activity classification

Volunteers presented themselves in light clothes and barefoot to collect anthropometric data related to weight and height, for this purpose a digital scale was used (Welmy, São Paulo, Brazil), with coupled stadiometer of maximum capacity equal to 200kg, containing coupled anthropometric ruler with scale from 1.00 to 2.00m. To calculate BMI, the equation where body mass represented in kilograms is divided by the square of height in meters (kg/m^2) has been used. For classification of individuals in the normal nutritional status (18.5 and 24.9 kg/m2), overweight (25.0 and 25.9 kg/m2) and obese (≥ 30.0 kg/m2) [18]. Regarding practice time, sample distribution was performed based on the percentile distribution. Thus three groups of analysis were constituted: less than 6 months of practice, from 6 months to 12 months and above 12 months.

Lung Function Assessment

In order to apply the spirometry test, we used a bidirectional spirometer (Care Fusion MicroLoop, San Diego, USA), with a volume transducer which measures expired air controlling body temperature conditions and the ambient air pressure with water vapor saturation, which avoids inaccuracies in temperature corrections dispensing individual calibration before each test. The product has a precision of 10 ml volume and 0.03 L/s ± 3% flow for the Forced Vital Capacity test (FVC) and its variables.

The variables observed in this study were forced vital capacity (FVC), forced expiratory volume in first second (FEV1) and peak expiratory flow (PEF).

FVC is performed through a deep and maximum breath followed by a forced expiratory maneuver reaching the maximum volume of air exhaled until the residual volume is reached (Barreto, 2002; Paulo, et al., 2015). FEV1, in turn, corresponds to the exhaled air volume in the first second of FVC, IT is a very valuable index in lung function evaluation, it has a good reproducibility and is more effort-independent, and it clinically deserves close observation by health professionals for diagnosis of respiratory disorders (Pereira, et al., 2002).

PEF is an important contribution indicator from the assessed individual and quality indicator presented at the beginning of blowing, it represents the maximum air volume that can be expelled during the FVC maneuver with results shown in liters per second (L/s), and it is a expiratory parameter dependent on effort by the assessed individual, on expiratory muscle strength, on airway caliber and total lung capacity (Orestesantunes, Gianini, Passarelli, & Gastaldi, 2012; Pereira, et al., 2002; Simsic et al., 2012). For the spirometry, no fasting was necessary, but coffee and tea should not be taken within the last six hours before the procedure due to their bronchodilator effect, alcoholic substances were not allowed in the last four hours, bulky meals were avoided one hour before and individual remained seated for five to ten minutes for rest before testing (Durmic, et al., 2015; McArdle, et al., 2001).

Forced spirometry had a minimum of three and a maximum of twelve possible execution attempts to be automatically select through the spirometer software, the top three results for normal status classification. The techniques used are certified by the Brazilian Society of Pulmonology and Phthisiology (SBPT) and as classification criterion it was proposed that as by Pereira (Pereira, et al., 2002).

Statistical Procedures

Statistical analysis was made by descriptive presentation of position values (minimum, maximum, average) and dispersion (standard deviation). Data normality was made using Shapiro-Wilk test. Group comparison was performed by analysis of variance (ANOVA) using Tukey *post hoc* analysis. We used the chi-square test for groups and variables association. The multiple linear regression test was also employed for verification of the impact of nutritional status and time of practice of physical activity on pulmonary function. The predicting variables are described by: regression coefficients (B); standard error for each parameter (SE B); standardized values for each coefficient (β) (Maroco, 2007). For the analysis, we have adopted statistical significance of $p < 0.05$, from the statistical package from Statistical Package for Social Sciences, version 17.0 (SPSS Inc. Chicago, IL).

Ethical Procedures

This study was approved by Plataforma Brasil's ethics committee, the national and unified basis of research records involving human subjects under number 39378714.5.0000.5547. All individuals subjected to the tests signed the free and informed consent statement.

Results

We evaluated 799 individuals of both genders, aged between 18 and 59 years, with 268 in the male group, average age of 34 years and 531 individuals in the female group, with an average age of 43 years. Average BMI among men was 25.54 kg/m², among women the average was 26.34 kg/m². The assessed physical activity time showed an average of 53 months of regular practice for men and 37 months of practice among women (Table 1).

Table 1. Descriptive sample values for anthropometric variables and physical activity time.

	Gender	n	Minimum	Maximum	Mean	Standard
Age (years)	M	268	18	59	33.82	12.69
	F	531	18	68	43.42	10.22
Body Mass (kg)	M	268	53.00	133.00	78.70	11.30
	F	531	45.70	118.00	68.33	11.40
Height (m)	M	268	1.56	1.93	1.75	0.07
	F	531	1.47	1.77	1.61	0.06
BMI (kg/m²)	M	268	19.50	36.20	25.54	3.18
	F	531	18.30	43.30	26.34	4.26
Pysical Activies Pratice (month)	M	268	1.00	360.00	53.12	72.32
	F	531	1.00	444.00	37.32	61.63

During spirometry, FEV1, FVC and PEF variables were analyzed. The male group had higher averages in all variables (Table 2).

Table 2. Descriptive sample values for the lung function variables.

	Gender	n	Minimum	Maximum	Mean	Standard Deviation
FEV1 (l)	M	268	1.91	6.19	4.03	0.71
	F	531	1.61	4.49	2.76	0.52
FVC (l)	M	268	2.79	6.61	4.86	0.76
	F	531	1.61	5.08	3.37	0.52
PEF (l/s)	M	268	3.00	14.77	10.16	1.67
	F	531	2.85	11.19	6.98	1.21

In the stratification of genders and through the classification of nutritional status (normal, overweight and obesity), in both genders the obese group showed lower averages in the pulmonary function test in all variables (figure 1 and 2). In both genders PEF showed no significant differences.

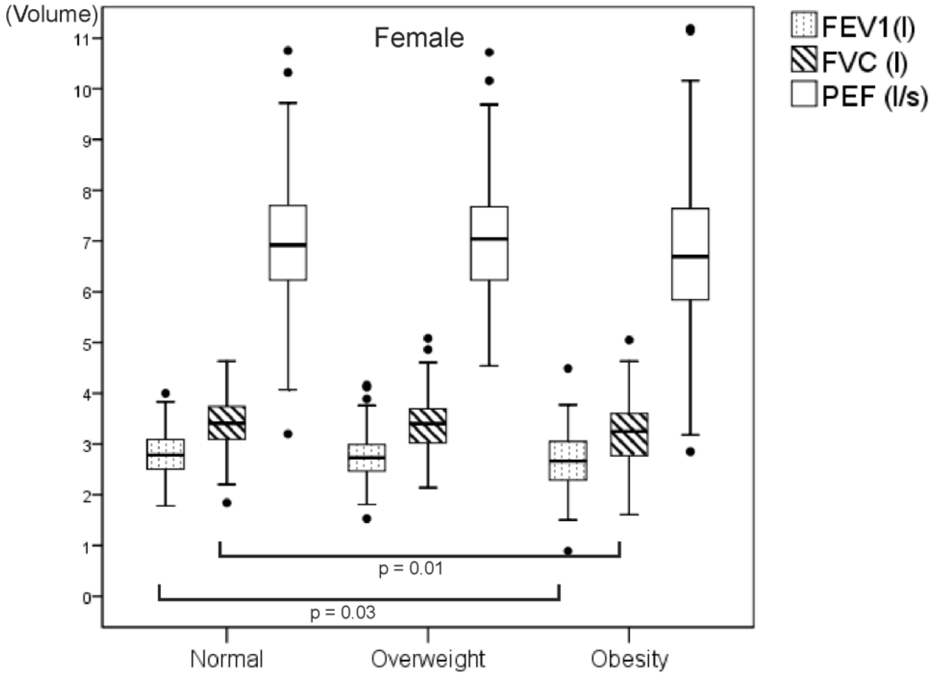

Figure 1. Comparison between lung function variables and nutritional status for females.

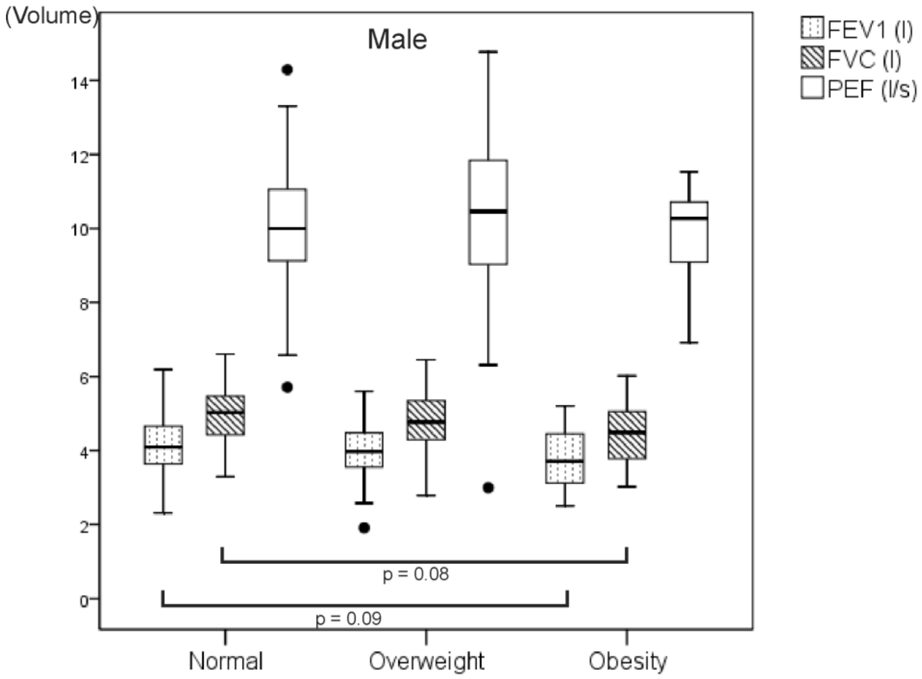

Figure 2. Comparison between lung function variables and nutritional status for males.

Table 3, in turn, presents classification characteristics of lung function and nutritional status of adults from both genders. There was a significant association between nutritional status and pulmonary function test, x^2= 16.39, p= 0.003 for men. What seems to represent, based on the relative risk than men with nutritional status above recommended were 1.9 more likely to have insufficient lung function test. Thus, data shows an association between an increased BMI and the risk of restrictive pulmonary disease. The figures presented no significance in women: x^2= 3.41, p= 0.492.

Table 3. Lung function classification characteristics and nutritional status among adults of both genders.

			Pulmonary Function			Total
			Normal	Restrictive	Obstructive	
Nutritional Stats	Normal	M	106 (76.%)	5 (3.6%)	27 (19.6%)	138(100%)
		F	196 (84.9%)	16 (6.9%)	19 (8.2%)	231(100%)
	Overweight	M	83 (77.6%)	11(10.3%)	13 (12.1%)	107(100%)
		F	174 (87.5%)	13 (6.5%)	12 (6.0%)	199(100%)
	Obesity	M	15 (65.2%)	6 (26.1%)	2 (8.7%)	23(100%)
		F	85 (85.0%)	10 (10.0%)	5 (5.0%)	100(100%)
	Total	M	204 (76.1%)	22 (8.2%)	42 (15.7%)	268(100%)
		F	455 (85.8%)	39 (7.4%)	36 (6.8%)	530(100%)

The cross-comparison between the practice time and the classification of pulmonary function showed no significant association with respect to analysis of the practice of physical activity in any of the values were of X^2= 2.00. p= 0.735 and X^2= 4.61. p= 0.329 for men and women respectively (Table 4).

Table 4. Lung function classification, characteristics and physical activities time among adults of both genders.

			Pulmonary Function			
			Normal	Restrictive	Obstructive	Total
Practice Time	Less than 6 month	M	54 (81.8%)	5 (7.6%)	7 (10.6%)	66 (100%)
		F	161 (83.0%)	19 (9.8%)	14 (7.2%)	194 (100%)
	From 6 to12 months	M	33 (75.0%)	3 (6.8%)	8 (18.2%)	44 (100%)
		F	58 (87.9%)	2 (3.0%)	6 (9.1%)	66 (100%)
	More than 12 months	M	117 (74.2%)	14 (8.8%)	27 (17.0%)	158 (100%)
		F	237 (87.5%)	18 (6.6%)	16 (5.9%)	271 (100%)
	Total	M	204 (76.0%)	22 (8.3%)	42 (15.7%)	268 (100%)
		F	456 (85.9%)	39 (7.3%)	36 (6.8%)	531 (100%)

Significant values were detected only for the BMI and age using the multiple linear regression test to explore the combined effects of nutritional status, age and time of practice of physical activity in pulmonary function (Table 5).

Table 5. Multiple linear regression to analyze the impact of nutritional status and practice time in the lung function variables.

		B	SE B	Β	R^2
Male	**FVC**				0.18
	Constant	5.73	0.37		
	BMI	-0.01	0.01	-0.14*	
	PAP	0.00	0.00	0.00	
	FEV1				0.30
	Constant	5.05	0.30		
	BMI	-0.03	0.01	-0.10*	
	PAP	0.00	0.00	-0.04	
	PEF				0.05
	Constant	9.55	0.82		
	BMI	0.06	0.03	0.11	
	PAP	0.00	0.00	0.10	
Female	**FVC**				0.15
	Constant	4.57	0.14		
	BMI	-0.02	0.01	-0.15*	
	PAP	0.00	0.00	-0.04	
	FEV1				0.27
	Constant	4.03	0.12		
	BMI	-0.01	0.00	-0.11*	
	PAP	0.00	0.00	-0.05	
	PEF				
	Constant	8.35	0.52		0.02
	BMI	-0.01	0.01	-0.02	
	PAP	0.00	0.00	-0.02	

Note: BMI = Body Mass Index; PAP = Pysical Activies Pratice (month); * $p<0.005$; B = regression coefficients; SE B = standard error for each parameter; β = standardized values for each coefficient.

Discussion

The results of this study showed a significant association between nutritional status and pulmonary function test mainly among men (x^2= 16.39. p= 0.003). suggesting that male individuals who are in nutritional status above recommended even if they practice physical activities they are 1.9 more likely to have poor results in pulmonary function tests.

These gender differences in pulmonary function may be related to body fat distribution and the obesity level. In female individuals body fat is more peripherally distributed. while in male individuals this distribution is usually thoraco-abdominal and obesity in that region is most often correlated with reduced FVC and FEV1 (Faria et al., 2014; Thakker, 2014). Fat deposits between muscles and other body structures may mechanically affect diaphragm expansion, and may also decrease lung and chest wall compliance. culminating with a decrease in lung volume and overload on inspiratory muscles (Genc, et al., 2014; Melo, de Melo, de Menezes Filho, & Santos, 2011; Paulo, et al., 2015; Ribeiro, Araújo, Souza-Machado, & Ribeiro, 2007; Thakker, 2014).

In a study analyzing spirometry in order to identify possible changes of their volumes and correlate them with obesity in patients eligible for bariatric surgery. we found a relationship between the small airways with significantly reduced lung size in obese men compared the obese women. One can then correlate an obstructive process of small airways lung function with the deposition of thoraco-abdominal fat among men (Aquino et al., 2015).

Both obese men and women showed lower averages in the respiratory variables observed in this study. similar to that found by other authors involving a group of obese and not obese sedentary. where those with more fat located in the abdominal region had more negative FEV1 and FVC both in men as in women and that relationship remained significant even after adjustments for age. height. BMI. social class. smoking. physical activity. prevalence of diseases such as bronchitis. emphysema and asthma (Thakker, 2014).

Another study of 179 individuals aged 18-36 years: 64 students with supervised physical activity minimum of four sessions/week; 66 students with supervised minimum of two sessions/week; 49 apparently healthy sedentary students. showed that the more BMI increased there is a tendency to FVC decrease (Paulo, et al., 2015).

As for the PEF variable which was also observed in this study it showed no significant difference between the nutritional statuses presented as normal. overweight and obese both for the female and for the male groups. This non significance of PEF in relation to nutritional status may be related to the association between airway size and lung size. where people with similar lung volumes do not necessarily have similar airway diameters (Dominelli et al., 2015; Sheel et al., 2009).

The analysis of the multiple linear regression indicated significance only for BMI and age on the results of FEV1 and FVC in both genders. Notice that exclusion criteria were: be a practitioner of physical activity for less than one month, have any known respiratory disease or have smoked at any time of life.

Pulmonary rehabilitation programs based on exercise and education have shown there is an improvement in functional capacity regarding physical exercises and life quality of individuals with lung disease. Similarly to what occurs with COPD. However, there were reports that benefits seem to last for up to nine months after pulmonary rehabilitation and then go into decline until twelve months (Spencer, et al., 2007).

That points to the fact that regular physical activity practicing time does not interfere in improving respiratory variables in the medium and long term. there really is an initial and important increase compared to sedentary individuals or to an individual with a respiratory disease. as shown in other studies (Durmic, et al., 2015; Humphreys, et al., 2014; Paulo, et al., 2015). This study researched a population that develops free physical activities offered by the city with a focus on quality of life, meaning that they are not athletes. Thus, high intensity exercises are not applied. This factor may have contributed to the non-interference of the practice time on pulmonary function.

This was observed in some high-level athletes where the generally found large lung volumes reflect genetic influences and body size characteristics. considering that exercise training does not appreciably change static lung volumes (McArdle, et al., 2001).

The way exercises are performed by the population, as well as a longitudinal analysis of the impact of physical activity time in lung function in the medium and long terms are suggested topics for future studies.

Conclusion

Average times of practice of physical activity of 53.12 ± 72.32 months for men and 37.32 ± 61.63 months for women were found in sample. However, it was verified that this is a variable that did not influence the values of pulmonary function, both, alone or combined with BMI.

Ultimately it is emphasized that in this study the nutritional status confirms its interference on respiratory function even among regular practitioners of physical activity. An association between increased BMI and the risk of restrictive lung disease was confirmed for males.

Abbreviations

FVC: Forced Vital Capacity; **FEV1**: Forced Expiratory Volume on the first second; **PEF**: Peak Expiratory Flow; **BMI**: Body Mass Index; **PA**: physical activity; **PAP**: Pysical Activies Pratice **SBPT**: Brazilian Society of Pulmonology and Phthisiology; **ANOVA**: analysis of variance

Corresponding Author

Wagner Luis RIPKA: Federal University of Technology - Paraná, Graduate Program in Electrical Engineering and Computer Science, Curitiba, BRAZIL, Email: ripka.w@gmail.com

Conflict of Interest

The authors have not declared any conflicts of interest.

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