Predicting Wingate Power From Lung Volumes

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Cardiovascular Research Laboratory, The University of Texas at Arlington, Arlington, TX; KINE 4400 December 9, 2015

Abstract

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INTRODUCTION: Two different measurements, static lung volume and dynamic lung volume are used to report lung size, volume, and contractility. Spirometric Respiratory Tests are one way to measure these different lung values. Anaerobic Power is used for short bursts of high intensity power and is mainly measured using the Wingate Anaerobic Test (WAnT). The relationship between lung function and anaerobic power in healthy individuals is not completely understood.

PURPOSE: The purpose of this study was to determine if lung volumes could be used to predict Wingate power.

METHODS: Six women (W; age 24.7 ± 4.8 yrs.) and five men (M; age 24.2 ± 4.4 yrs.) that attended the University of Texas at Arlington, volunteered to participate in this study. The subjects performed a spirometric respiratory function test followed by a Wingate Anaerobic Test (WAnT). During the spirometric function test, each subject wore a nose clip and performed a series of breathing maneuvers into a mouthpiece attached to a spirometer. Lung function values including forced vital capacity (FVC), forced expiratory volume at one second (FEV_1), and peak expiratory flow (PEF) were recorded. The WAnT required for subjects to pedal for 30 s at maximum speed against a constant resistance. The WAnT power parameters recorded include mean power (W), peak power (W), normalized mean power (W/kg), and normalized peak power (W/kg)). Statistical analyses were performed using SPSS to compute the correlation between WAnT power and lung. Multiple linear regression was used to compute prediction equations for WAnT power from FEV_1, PEF, and FVC with alpha set at 0.05.

RESULTS: Gender and lung function significantly predicted WAnT power, $p < 0.05$.
The prediction equation for normalized peak power (W/kg) was

$$PP = 4.12(Gender) - 4.45\,(FVC) + 6.58\,(FEV_1) - 1.61(PEF) + 11.54,\ R^2 = .82,\ SEE = 1.54.$$

Similar equations were generated for normalized mean power, peak power and mean power in the WAnT from gender and lung function. Mean ± SD for each variable by gender were: FVC (W: 4.0 ± 0.9 L, M: 5.3 ± 1.1 L), FEV_1 (W: 3.1 ± 0.6 L/sec, M: 3.6 ± 1.3 L/sec), PEF (W: 4.9 ± 1.8 L/min, M: 5.4 ± 2.8 L/min) and Wingate power parameters: MP (W: 395.8 ± 50.2 W, M: 586.8 ± 116.1 W), PP (W: 671.7 ± 123.5 W, M: 879.6 ± 228.2 W), MP/Wkg (W: 5.85 ± 0.6 W/Kg, M: 7.0 ± 2.0 W/Kg), PP/Wkg (W: 10.0 ± 2.4 W/Kg, M: 10.6 ± 3.6 W/Kg)).

CONCLUSION: The results of this study indicate that lung volumes can be used to predict Wingate power in both men and women. Lung function and gender significantly explained 82 – 94% of the variance in Wingate power variables.

Introduction

Two different measurements, static lung volume and dynamic lung volume are used to report lung size, volume, and contractility. Static lung volumes are mainly a reflection of one's height and body structure. Dynamic lung volumes are affected by one's height as well as changes in muscle strength. Spirometric respiratory testing measures the amount of air going into and out of the lungs. This test is used to measure lung function and can give a better understanding of respiratory physiology. Respiratory muscles can increase with exercise, which is usually seen in highly trained endurance athletes. Anaerobic power utilizes the ATP-PC system, and is used for short bursts of high intensity power. Anaerobic Power plays an important factor in sport or exercise performance where short-term explosive movements take place. Although there is no way to test 100% of one's anaerobic power, the 30 second Anaerobic Wingate Test (WAnT) is one of the most widely used tests in this field. The WAnT is an exhausting test that measures the lower body's ability to produce power.

The relationship between lung function and anaerobic power in healthy individuals is not completely understood.

The purpose of this study was to determine if lung volumes could be used to predict Wingate power.

Methods

Six women (W; age 24.7 ± 4.8 yrs.) and five men (M; age 24.2 ± 4.4 yrs.) that attended the University of Texas at Arlington volunteered to participate in this study. The subjects were all healthy, had no prior respiratory issues, and exercised moderately for at least 2 days per week. The women had an average body composition of (W; BMI 26.2 ± 4.1 kg/m^2) and the men (M; BMI 26.9 ± 2.0 kg/m^2). The subjects had an average height of (W: 1.62 ± 0.03 m, M: 1.78 ± 0.11 m), and average weight of (W: 68.7 ± 11.8 Kg, M: 86.4 ± 15.5 Kg). The subjects performed a spirometric respiratory function test using a Sensormedics 2130 Spirometer and respiratory analyzer followed by a Wingate Anaerobic Test (WAnT) using a Monark Cycle Ergometer. During the spirometric function test, each subject wore a nose clip and performed a series of breathing maneuvers into a mouthpiece attached to a spirometer. The highest lung function values including forced vital capacity (FVC), forced expiratory volume at one second (FEV_1), and peak expiratory flow (PEF) were recorded. The WAnT required for subjects to pedal for 30 s at maximum speed against a constant resistance. The WAnT power parameters recorded include mean power (W), peak power (W), normalized mean power (W/kg), and normalized peak power (W/kg). Statistical analyses were performed using SPSS to compute the correlation between WAnT power and lung. Multiple linear regression was used to compute prediction equations for WAnT power from FEV_1, PEF, and FVC with alpha set at $p \leq 0.05$.

Results

Subject demographics are located in table 1.

Table 1: Subject Demographics

	Male (n=5)				Female (n=6)			
	Mean	SD	Max	Min	Mean	SD	Max	Min
Height (m)	1.78	± 0.11	1.90	1.65	1.62	± 0.06	1.70	1.54
Weight (Kg)	86.42	± 15.56	106	65	68.67	± 11.78	86	56
BMI (kg/m^2)	26.94	± 1.99	29.4	23.9	26.2	± 4.1	33.6	22.4
Age (yrs)	24.2	± 4.44	32	21	24.7	± 4.8	32	20

Results (cont'd)

Gender and lung function significantly predicted WAnT power, $p < 0.05$. The prediction equation for normalized peak power (W/kg) was

$$PP = 4.12(Gender) - 4.45\,(FVC) + 6.58\,(FEV_1) - 1.61(PEF) + 11.54,$$
$$R^2 = .82,\ SEE = 1.54.$$

Similar equations were generated for normalized mean power, peak power and mean power in the WAnT from gender and lung function. Mean ± SD for each variable by gender are given in table 2. In Figures 1-4, linear regression plots are given.

Table 2: Mean ± SD for lung function and Wingate power parameter variables

	Male		Female	
	Mean	SD	Mean	SD
FVC (L)	5.3	± 1.1	4.0	± 0.9
FEV_1 (L/sec)	3.6	± 1.3	3.1	± 0.6
PEF (L/min)	5.4	± 2.8	4.9	± 1.8
MP (W)	586.8	± 116.1	395.8	± 50.2
PP (W)	879.6	± 228.2	671.7	± 123.5
MP/W_{kg} (W/Kg)	7.0	± 2.0	5.85	± 0.6
PP/W_{kg} (W/Kg)	10.6	± 3.6	10.0	± 2.4

Figure 1: Partial regression plot of the relationship between FVC and PP/W_{kg}

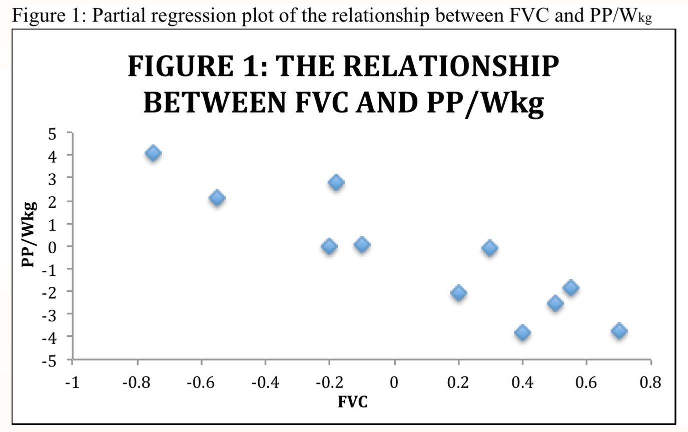


Figure 2: Partial regression plot of the relationship between FVC and PP/W_{kg}

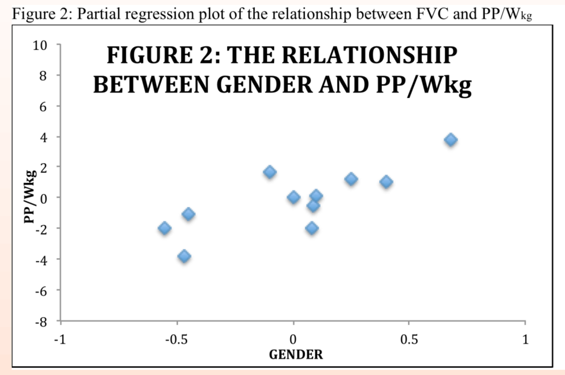


Figure 3: Partial regression plot of the relationship between FEV_1 AND PP/W_{kg}

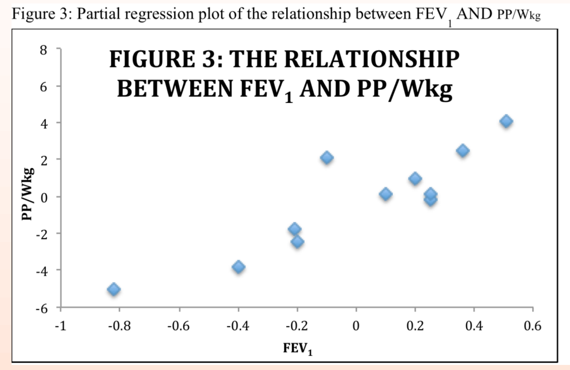
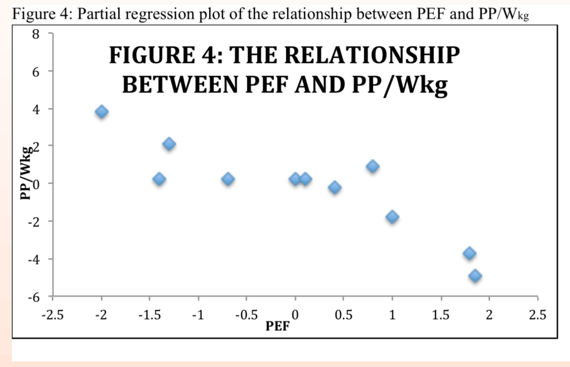


Figure 4: Partial regression plot of the relationship between PEF and PP/W_{kg}



Conclusions

Dynamic and static lung function values are normally used when testing for lung diseases and have not been found to provide information relating to anaerobic fitness levels. However, in individuals who exercise regularly, increases in physiological and respiratory functions have been found. A strong correlation between FVC, FEV, FEV_1, gender, and PP/Wkg, which was statistically significant ($R^2 = .82$, $p = 0.02$). The predictor variables were also all statistically significant, (Gender: $p = 0.02$, FVC: $p = 0.00$, FEV_1: $p = 0.00$, PEF: $p = 0.01$) Lung function and gender significantly explained 82 – 94% of the variance in Wingate power variables. This experiment could be improved by testing different age groups, a wider variety of body types, and using a larger group of subjects. The results of this study indicate that lung volumes can be used to predict Wingate power in both men and women.