Biology of Sport, Vol. 26 N^{o}1, 2009

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EXAMINATION OF RELATIONSHIP BETWEEN 30 SECOND WINGATE TEST PERFORMANCE AND SPIROMETRIC RESPIRATORY FUNCTIONS IN YOUNG ADULTS

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Abstract. Objective: This work has been planed to investigate whether the correlation between one of the important component of the sports performance spirometric respiratory function (SRF) and 30 s Wingate Test (WT) parameters of young adults who have different physical fitness level. Materials and Methods: This work included a total of 166 subjects those are 98 young boys (20.30±1.93) and 68 young girls (19.65±2.18). The subjects were divided into two groups namely regular exercises group (EG) who make a regular exercises during 4.0±1.50 years and sedentary groups (SG). Both group's subjects have similar age, height, weight and body mass index (BMI kg/m^2). All the subjects were performed spirometric respiratory function test and WT power performance test. Statistical analyses were performed by SPSS computer program and the groups were compared to each other by using Independent Samples t test calculation and the correlation relation levels were calculated by using linear regression analysis. Results: In the view of physical peculiarities, it has not been found any difference between research groups that EG and SG (P>0.05). In the meaning of the measured spirometric respiratory functions and WT power performance, with the advantage of making regular sports, according to SG groups, the boys and girls EG groups showed differences (P<0.05). The correlational relationship between the spirometric and WT power parameters; it has been observed significant correlation between peak power (PP), mean power (MP), peak power/weight (PP/W_{kg}), mean power/weight (MP/W_{kg}) form WT parameters and VC, FVC, FEV_1, FEV_1/FVC (%), FEF_{25-75}, PEF and MVV form respiration function (P<0.05 and P<0.001). On the other hand, it has not been found any significant correlation between WT anaerobic fatigue index (AFI %) and respiratory functions (P<0.05). Conclusion: In this work, the tested spirometric respiratory functions have got an active role in the WT power parameters. It has been confirmed that there is a positive tendency

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significant higher correlation between VC, FVC, FEV_1, FEV_1/FVC (%), FEF_{25-75}, PEF, MVV and WT parameters in both antrene and non-antrene groups.

(Biol.Sport 26:56-70, 2009)

Keywords: Spirometry - Respiratory functions – Exercise - Wingate test

Introduction

Training is considered as a set of exercises giving way to the physical, social, mental and psychological development of an individual. Individuals involved in sports do a variety of exercises in the short and long term trying to succeed in the sports branch they have chosen to specialize. These activities result in some physical and physiological developments depending on the acute and chronic condition of the exercises. As the sportsmen do exercises during training such as running, jumping, bouncing, stretching etc., their circulatory and respiratory systems are affected beyond the normal level. Biological adaptations of the sportsmen to the exposure of these exercises may vary according to their sport and training age.

Spirometric respiratory function tests help us to better understand the lung size and respiratory physiology. As some lung sizes are measured just by a spirometer, it is advised to regularly test the respiratory functions of the sportsmen. Respiratory muscles have the form of skeletal muscle; therefore a significant increase is highly probable with strength and endurance exercises [13]. This is more commonly seen in athletes and swimmers.

As sportsmen are highly loaded, their ability to transform explosive power and energy into power in relation to non-oxygen energy systems is defined as anaerobic power [2]. Anaerobic power is an important criterion for sportive performance in the sports branches where short-term explosive effort is made [2,13,22]. Although currently there is not a method that accurately measures the anaerobic power, some tests partially reflect the maximum anaerobic power of the individuals [2,13,20]. Wingate 30 s anaerobic bike test (WT) is a generally accepted and widely used method referred to determine anaerobic power, as a practical and usable test it has a respectful place in the literature [3,4,15,16,17,21,25]. It is an exhausting test that should be used with a population accustomed to strenuous vigorous exercise. The resulting data is an indirect measurement for the ability of a subject's lower body to produce high levels of power. Test re-test reliability of the WT has generally been reported to be higher than r=0.94 [25]. Validity of the WT is difficult to measure since there is no universally accepted “Gold Standard” of anaerobic measurement [28]. However, laboratory studies have been performed comparing the WT and field tests of anaerobic power. Moderate correlations with the WT have been demonstrated in short explosive field measures like the vertical jump (mean power r=0.74) [29].

There was a report of lower anaerobic capacity related to respiratory function in children with asthma, but in fact, the correlations between spirometric respiratory function (SRF) and anaerobic power in healthy young persons are unclear. The aim of this research is to determine whether there is a correlational connection between the 30 s Wingate Test and respiratory function of young subjects who are engaged in or not engaged in sport activities.

Materials and Methods

Subjects: 166 healthy volunteers who consisted of 98 young men (age; 20.30±1.93) and 68 women (age; 19.65±2.18) participated the research. They had just completed the high school education and they were regularly busy with physical activities but were sedentaries who were not engaged in sports. Two research groups were formed out of them; a regular exercise group (EG) and a controlling sedentary group (SG). The study was approved by the local ethics committee according to the code of Ethics of the World Medical Association (Helsinki Declaration of 1975 as revised in 1983). All the subjects fully informed of any risks and discomforts associated with the experiment before giving their informed consent to participate. The subjects were accepted voluntarily and signed informed consent. The study included descriptive data collection, Wingate test and a spirogarphic study.

Regular exercise groups (EG): This group consists of 60 young men (age, 20.25±1.87) and 42 young women (age, 19.65±1.93) who had just finished high school, and who performed regular physical activities since approximately 4.0±1.50 years although they were not engaged in sports requiring jumps skills. During the last 6 months, subjects have regularly performed their aerobic type sportive activities (about 7.0-10.4 km jogging and run, gymnastic-stretching-flexibility-balance-coordination exercises) and condition trainings (endurance, power and strength exercises) for 3 h per a day in 5 days of a week. The average body mass index in the men was 21.56±1.58 kg/m^2, and average body mass index in women was 20.14±1.88 kg/m^2.

Sedentary groups (SG): These consist of healthy 38 young men and 26 young women who were not engaged in sports. The average age of the young men was

20.42±1.71 and the average age of the young women was 19.86±2.65. The average body mass index of the men was calculated as 21.60±2.15 kg/m^2; the woman is body mass index was calculated as 20.34±2.25 kg/m^2 in the sedentary group.

Measurements

Anthropometry and body composition measures: The length (cm) was measured with Holtain sadiometer, the weight (kg) was measured with electronic scale [12]. Measurements of Body Weight (BW) (kg) using calibrated electronic scales and standing Ht (m) against a wall-mounted stadiometer were obtained, from which body mass index (BMI; kg/m^2) was determined. Skinfold thicknesses (SFT) were measured at the biceps, triceps, subscapular and supra-iliac sites, using Holtain Tanner-Whitehouse skinfold calipers (Holtain Ltd, Crosswell, Crymych, Dyfed, UK), as described by Durnin and Womersley [11].

Anthropometry and skinfold thickness measurements: Standing height was measured using a stadiometer fixed to the wall and recorded to the nearest 0.1 cm. Body weight was noted between 7 and 10 am after an overnight fast and immediately after voiding, with subjects wearing light indoor clothing and no shoes, on a beam balance and recorded to the nearest 100 g. Mid-arm, waist and hip circumferences were measured as described by Callaway *et al.* [8]. Skinfold thickness (SFT) at four sites (biceps, triceps, subscapular and supra-iliac) were measured on the right side of the body and recorded to the nearest 0.2 mm. Each skinfold was measured in triplicate and the mean of the three measurements used for further analyses. The sum of the four skinfold thicknesses were then used in the sex and age specific equations of Durnin and Womersley [11] for the prediction of body density . Body fat percentage (BF %) was calculated from body density. Fat mass (FM) was then calculated and FFM was estimated from the difference of body weight and FM.

Spirometric mesurements: Lung functions (VC, FEV_1, FVC, FEV_1/FVC, PEF, FEF_{25-75}, MVV) were measured using Vitalograph Spirometer acording to standart of American Thoraks Soceity (ATS) and Eurpean Respiration Soceity (ERS) [1,26].

The subjects then moved to a cycle ergometer and performed a 30-s sprint at maximal speed against a resistance of 7.5 % of the subject’s body weight (Wingate test) [3]. A friction-braked cycle ergometer with a pan-weighted loading system (834E Monark, Verberg, Sweden), fixed with an optical sensor and computerized software (OptoSensor 2000^{TM}, Sport Medicine Industries, St. Cloud, USA) was used [24]. The subjects were caused to have a warming up before the tests and cycled with 75 W till the number of heartbeats became 140-150 kwh/min. The subject had to pedal the ergometer pedal with a maximal speed. Then, the subjects had to work 30 s with maximal speed with a constant resistance (75 g/kg). The WT was conducted according to the widely accepted recommendations for standardization [15,29]. The subjects were motivated during the test to pedal with maximal speed. Each number of performed pedals was recorded in each 5 s of the certain 30 s on the PC with Wingate software. The WT was conducted according to the widely accepted recommendations for standardization [15,29]. Test results are divided into six equal periods of 5-s where peak power, in Watts, is the highest average power output during any one 5-s period and mean power is the mean of all six 5-s periods. Fatigue percentage is the difference between peak power and the power from the lowest 5-s period.

Statistical analyses: SPSS statistic package program was used to evaluate the results of the study. The data are presented as the mean ±SD. Independent Samples t test and two way ANOVA, was applied to determine statistically significant differences between sedentary and exercise groups. Regression analysis method was used for the linear regression matrix correlation between parameters, R score were noted and the significance levels were determined. The graphics and regression linear curves were additionally drawn in the scatter graphic mode in SSPS.

Results

Table 1
Physical characteristics comparison of EG versus SG by sex

	Men (n=98)		Women (n=68)	
	EG (n=60)	SG (n=38)	EG (n=42)	SG (n=26)
Physical Characteristics	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Age (year)	20.25±1.87	20.42±1.71	19.65±1.93	19.86±2.65
Height (cm)	173.00±4.90	172.50±5.80	160.23±5.13	159.59±6.51
Weight (kg)	65.02±4.82	64.92±6.20	51.65±4.11	51.59±6.54
BMI (kg/m^2)	21.73±1.58	21.82±2.15	20.12±1.88	20.25±2.25
Body Fat (%)	11.69±2.85	10.96±2.92	17.72±2.91	18.14±5.26
Fat-free body mass (kg)	57.49±3.98	57.81±5.03	42.50±3.18	41.21±4.12
Body fat weight (kg)	7.53±1.99	7.11±1.84	9.15±1.93	9.28±3.81

Physical parameters: As summarized in Table 1, no statistical difference was present between the physical parameters such as age, height, weight, BMI, body fat percentage, fat-free body mass (kg), and body fat weight of young men and women (P>0.05).

Table 2
Respiration functions and Wingate testing (WT) power parameters comparison of EG versus SG by sex

	Men (n=98)		Women (n=68)	
	EG (n=60)	SG (n=38)	EG (n=42)	SG (n:26)
Respiration Functions	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
VC (L)	5.56±0.50***	4.94±0.62	4.25±0.67*	3.86±0.87
FVC (L)	5.47±0.59***	4.74±0.75	4.14±0.52***	3.70±0.50
FEV_1 (L)	4.88±0.61***	4.38±0.67	3.73±0.38**	3.22±0.71
FEV_1/FVC (%)	108.15±7.83	106.69±9.28	100.21±11.79	98.38±8.54
PEF (L)	10.05±1.82*	9.08±2.25	6.96±1.50***	5.44±1.2.22
FEF_{25-75} (L)	6.37±1.35**	5.56±1.65	4.81±1.26**	3.95±1.09
MVV (L)	183.64±23.14***	164.32±24.96	139.90±14.43**	129.17±16.97
WT Test Parameters				
First 5 s	586.28±71.36**	548.40±96.94	343.84±54.95*	298.84±68.65
Second 5 s	520.60±51.39***	478.40±77.02	296.86±42.45*	245.83±61.19
Third 5 s	487.82±49.63***	447.26±75.15	277.05±39.79*	231.58±49.25
Fourth 5 s	443.97±42.38***	404.91±69.96	257.51±39.12*	215.94±40.60
Fifth 5 s	400.01±43.61***	366.52±65.52	239.51±39.37*	198.33±36.09
Sixth 5 s	360.31±57.66**	327.78±62.59	220.19±36.68*	175.00±34.42
PP (W)	589.28±70.59**	553.16±96.91	346.91±51.05*	301.39±68.66
PP/W_{kg} (W)	9.06±0.99*	8.79±1.20	6.71±0.95*	5.93±2.02
MP (W)	466.09±45.37***	427.26±60.47	272.96±34.49***	228.28±48.08
MP/W_{kg} (W)	7.18±0.62**	6.82±0.70	5.28±0.69**	4.48±1.42
AFI (%)	38.33±9.60*	40.24±8.80	35.61±11.44*	38.35±11.86

*P<0.05, **P<0.01, ***P<0.001

Abbreviations in Table 1 and Table 2:
EG - exercise group; SG - sedentary group; WT - Wingate test; BMI - body mass index; VC - vital capacity; FVC - forced vital capacity; FEV_1 - forced expired volumes in one s; FEV_1/FVC - ratio of FEV_1/FVC; PEF - peak expiratory flow;

FEF_{25-75} - forced expiratory flow at 25% to 75% FVC; MVV - maximum voluntary ventilation; PP - peak power; PP/W_{kg} - peak power/weight' MP - mean power; MP/W_{kg} - mean power/weight; AFI% - anaerobic fatigue index

Spirometric test results: Spirometric test result presented in Table 2. Results of the tests demonstrated significant differences on VC, FVC, FEV_1, PEF, FEF_{25-75} and MVV values between EG and SG of both men and women (levels: P<0.05, P<0.01, P<0.001). But it was found no significant differences on FEV_1/FVC between EG and SG groups (P>0.05).

Wingate Testing (WT) parameters: As indicated in Table 2, WT parameters including peak power (PP), mean power (MP), mean power/weight (MP/W_{kg}) peak power/weight (P/W_{kg}), anaerobic fatigue index (AFI %) and WT power values in each 5 s intervals throughout 30 s, were better in EG than SG of both men and women as having the advantage of being engaged in physical advantages (levels: P<0.05, P<0.01, P<0.001).

Table 3

The relationship levels between respiration functions and power parameters PP, PP/W_{kg} of WT as linear regression matrix

Linear Regression Matrix (R Square)

Parameters	Study Groups	VC (L)	FVC (L)	FEV_1 (L)	FEV_1/FVC (%)	FEF_{25-75} (L)	PEF (L)	MVV (L)
	EG	0.626*	0.643*	0.673*	0.412*	0.593*	0.686*	0.669*
PP (W)	SG	0.574*	0.510*	0.514*	0.297**	0.456*	0.681*	0.514*
Peak power	Men	0.268**	0.322**	0.275**	0.128	0.315*	0.365*	0.269**
	Women	0.257**	0.330**	0.295**	0.035	0.423*	0.448*	0.295**
	Total	0.626*	0.610*	0.622*	0.364*	0.555*	0.701*	0.620*
	EG	0.437*	0.501*	0.507*	0.276**	0.489*	0.526*	0.500*
PP/W_{kg} (W)	SG	0.559*	0.411*	0.455*	0.298**	0.444*	0.583*	0.455*
Peak power/ Weight	Men	0.311**	0.262**	0.289**	0.134	0.283**	0.225**	0.280**
	Women	0.234**	0.292**	0.287**	0.072	0.292**	0.300**	0.287**
	Total	0.535*	0.504*	0.513*	0.291**	0.500*	0.582*	0.510*

Subjects in populations of study groups; EG=102, SG:=64, men=98, women=68, total=166; correlation is significant at the P*<0.001, P**<0.05

Table 4
The relationship levels between respiration functions and power parameters MP, MP/W_{kg} and AFI (%) of WT as linear regression matrix

Linear Regression Matrix (R Square)

Parameters	Study Groups	VC (L)	FVC (L)	FEV_1 (L)	FEV_1/FVC (%)	FEF_{25-75} (L)	PEF (L)	MVV (L)
	EG	0.698*	0.729*	0.755*	0.441*	0.579*	0.718*	0.748*
MP (W)	SG	0.610*	0.611*	0.633*	0.287**	0.529*	0.694*	0.633*
Mean power	Men	0.318*	0.305*	0.389*	0.065	0.301**	0.322*	0.374*
	Women	0.267**	0.409*	0.406*	0.099	0.557*	0.610*	0.406*
	Total	0.677*	0.693*	0.713*	0.375*	0.580*	0.722*	0.710*
	EG	0.571*	0.635*	0.621*	0.315**	0.499*	0.599*	0.610*
MP/W_{kg} (W)	SG	0.610*	0.556*	0.558*	0.264**	0.469*	0.589*	0.558*
Mean power/ Weight	Men	0.280**	0.235**	0.261**	0.007	0.255**	0.289**	0.241**
	Women	0.240**	0.408*	0.307**	0.051	0.421*	0.445*	0.307**
	Total	0.615*	0.622*	0.608*	0.294*	0.514*	0.616*	0.603*
	EG	0.138	0.096	0.082	0.021	0.054	0.023	0.097
AFI (%)	SG	0.003	0.085	0.022	0.146	0.210	0.185	0.022
Fatigue Index	Men	0.135	0.113	0.127	0.066	0.106	0.105	0.198
	Women	0.165	0.228	0.148	0.090	0.132	0.206	0.148
	Total	0.166	0.184	0.121	0.072	0.043	0.032	0.132

Subjects in populations of study groups; EG=102, SG=64, men=98, women=68, total=166; correlation is significant at the; P*<0.001, P**<0.05

The relationship between Wingate and spirometric test results: The correlations (linear regression) between Wingate test parameters and spirometric test results were presented as the groups of EG, SG, Men, Women and Total population in Table 3 and Table 4. As shown in Table 3 and Table 4, a significant correlation observed WT parameters including PP, PP/W_{kg}, MP and MP/W_{kg} between spirometric test results including VC, FVC, FEV_1, FEV_1/FVC (%), FEF_{25-75}, PEF and MVV in EG, SG and total Group (P<0.05, P<0.01) (Tables 3and 4). However, a significant correlation AFI (%) and spirometric test results was no available in all groups (P>0.05) (Table 4). As an example, the level of correlational relationship and regression matrix between VC which is a parameter of spirometric test, and PP and AFI (%) parameters were presented in Fig. 1. In addition, there were no significant correlation between WT parameters and FEV_1/FVC (%) levels in Men and Women groups (P>0.05).

Table 5
The relationship levels between respiration functions and first, s and third five s power values of WT as linear regression matrix

Linear Regression Matrix (R Square)

Parameters	Study Groups	VC (L)	FVC (L)	FEV_1 (L)	FEV_1/FVC (%)	FEF_{25-75} (L)	PEF (L)	MVV (L)
	EG	0.602*	0.621*	0.650*	0.384*	0.567*	0.661*	0.646
WT power	SG	0.573*	0.509*	.514*	.298**	0.456*	0.680*	0.514*
values	Men	0.255**	0.322**	0.372**	.120	0.314*	0.364*	0.366**
of first 5 s	Women	0.244**	0.313**	0.279**	0.069	0.359*	0.402*	0.279**
	Total	0.615*	0.601*	0.610*	0.349*	0.543*	0.689*	0.609*
	EG	0.657*	0.725*	0.735*	0.410*	0.574*	0.685*	0.735*
WT power	SG	0.576*	0.511*	0.526*	0.299**	0.439*	0.611*	0.526*
values	Men	0.258**	0.258**	0.293**	0.091	0.251**	0.234**	0.294**
of second 5 s	Women	0.245**	0.332**	0.308**	0.086	0.457*	0.483*	0.308**
	Total	0.646*	0.658*	0.665*	0.367**	0.541*	0.670*	0.665*
	EG	0.666*	0.725*	0.732*	0.405*	0.572*	0.679*	0.729*
WT power	SG	0.590*	0.514*	0.557*	0.276**	0.471*	0.639*	0.557*
values	Men	0.347*	0.323*	0.336*	0.051	0.279**	0.264**	0.333*
of third 5 s	Women	0.308**	0.302**	0.302**	0.090	0.470*	0.507*	0.302**
	Total	0.659*	0.673*	0.678*	0.355*	0.556*	0.680*	0.677*

Subjects in populations of study groups; EG=102, SG=64, men=98, women=68, total=166; Correlation is significant at the; P*<0.001, P**<0.05

WT power parameters showed correlation in all group populations including EG, SG, Men, Women and Total. As shown in Table 5 and Table 6, WT power performance values recorded in each 5 s were correlationally related with the values of VC, FVC, FEV_1, FEV_1/FVC (%), FEF_{25-75}, PEF and MVV in EG, SG and Total Group(P<0.05, P<0.01) (Table 5, Table 6). There were no significant correlation between five s WT parameters and FEV_1/FVC (%) levels in men an women groups (P>0.05).

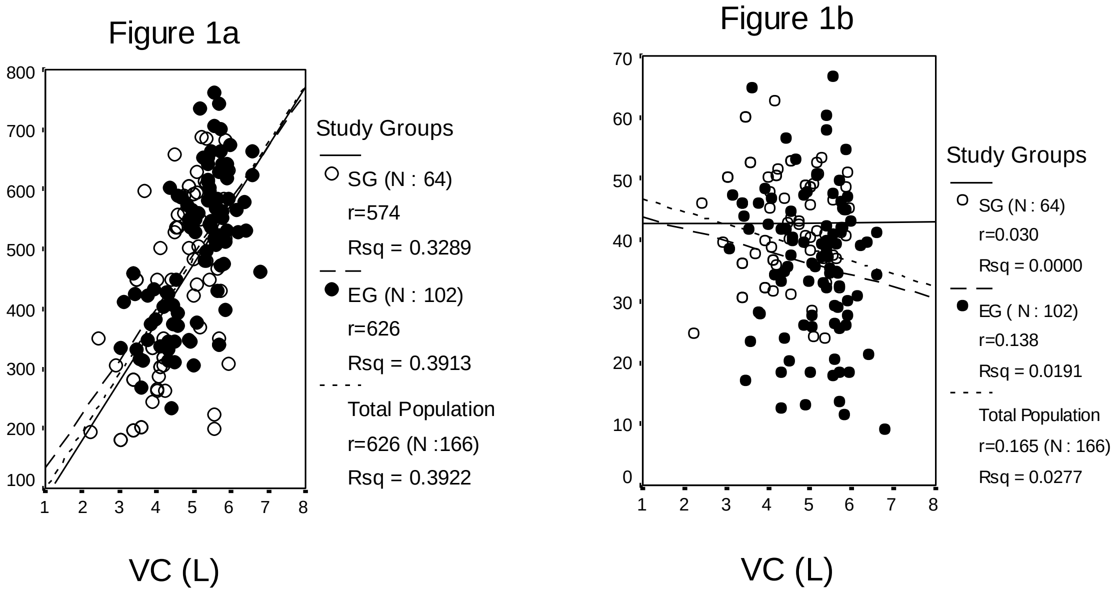

Fig. 1
The relationship levels between vital capacity (VC) and WT of peak power (PP) and fatigue index (AFI %) according

to the populations of EG, SG and total groups

Table 6
The relationship levels between respiration functions and fourth, fifth and sixth five s power values of WT as linear regression matrix

Linear Regression Matrix (R Square)

Parameters	Study Groups	VC (L)	FVC (L)	FEV_1 (L)	FEV_1/FVC (%)	FEF_{25-75} (L)	PEF (L)	MVV (L)
WT power values of fourth 5 s	EG	0.678*	0.703*	0.723*	0.405*	0.543*	0.672*	0.722*
	SG	0.595*	0.553*	0.538*	0.268**	0.418*	0.599*	0.538*
	Men	0.419*	0.329**	0.323*	0.035	0.285**	0.234**	0.322*
	Women	0.335**	0.377**	0.341**	0.078	0.451*	0.520*	0.341**
	Total	0.671*	0.673*	0.666*	0.335*	0.523*	0.660*	0.667*
WT power values of fifth 5 s	EG	0.617*	0.634*	0.655*	0.374*	0.502*	0.631*	0.656*
	SG	0.571*	0.550*	0.523*	0.215**	0.383*	0.564*	0.523*
	Men	0.335*	0.249**	0.235**	0.018	0.324**	0.273**	0.237**
	Women	0.331**	0.432*	0.389*	0.037	0.445*	0.542*	0.389*
	Total	0.631*	0.638*	0.625*	0.296*	0.488*	0.625*	0.626*
WT power values of sixth 5 s	EG	0.599*	0.631*	0.673*	0.329*	0.462*	0.544*	0.634*
	SG	0.541*	0.520*	0.491*	0.257**	0.365**	0.548*	0.491*
	Men	0.323*	0.256**	0.273**	0.012	0.276**	0.232**	0.225**
	Women	0.282**	0.440*	0.376**	0.041	0.427*	0.499*	0.376**
	Total	0.611*	0.626*	0.623*	0.280**	0.463*	0.578*	0.604*

Subjects in populations of study groups; EG=102, SG=64, men=98, women=68, total=166; correlation is significant at the: P*<0.001, P**<0.05

Discussion

Different dynamic and static lung function tests can indicate the severity of obstructive and restrictive lung diseases. However, such tests generally provide little information about aerobic and anaerobic fitness or exercise performance if the values fall within the normal range [22]. For example no difference emerges when comparing the average FVC of prepubescent and Olympic wrestlers, middle distance runners, and untrained, healthy subjects [27].

On the other hand, as a result of regular sportive activities, in addition to the physical and physiological developments of the individuals, respiratory function increases are observed [2,8,24]. Trained people have higher exercise and resting lung volume and capacities than those of sedentary people [2,11,12,22]. The studies revealed that VCs in physical education students are higher than that of sedentary and, among these students boys outperform girls [2]. Dincer *et al.* [10] found the VC values are higher for sportsmen than sedentary. Groups with a training programmed at FVC and FEV_1 values, a significant increase is observed [24]. It is a well-known fact that heart beat volume of sportsmen increase and pumps sufficient blood to the periphery with less effort [13]. The respiratory parameter values of exercise group (EG) above the normal level and, development of 'sportsmen bradicardy' in heart due to regular sports activities are expected results of this study that are bound to the increases occurred in the lung volume capacities. In addition, it can be inferred that regular training programmes of EG group has positive effects on the respiratory function of the subjects.

Trained individuals are known to have high muscle strength and respiratory efficiency compared to sedentary people [2,11,12,22]. It is clear that muscle power and some respiratory functions may change according to the factors such as position, body sizes and age [2,3,10,12,14,21]. To prevent that and achieve the purpose of the study, the subjects have been selected among healthy people of similar physical characteristics (age, height, weight, BMI (body mass index), body fat percentage, body fat weight, fat-free body mass), therefore no difference between physical properties of the subjects (EG and SG) has been found ($P<0.05$, Table 1).

In this study, it is observed that in the analysis of regression between WT power parameters, respiratory functions for Men and Women group populations, r score and level of significance are low; for EG, SG and whole group populations, r score, and level of relation are higher (Tables 5, and 6). The high number of subjects may be considered as a relation level-raising factor for the correlation and regression calculations.

Training advantaged EG groups outperform SG groups in terms of WT power performance recorded each 5 s and WT (PP, $PP/_{Wkg}$, MP, $MP/_{Wkg}$ ve AFI %) average power parameters ($P<0.05$, $P<0.001$). Moreover, Men subjects were more successful in leg strength and WT test as their muscle structures are different from Women (Table 1).

During WT, cramping of the muscle reflects first-degree mechanic-chemical transformation (concentric or isotonic cramps). Mostly cramping component of the muscle, concentric cramp functions [5,6,19]. Generally, loss of performance as well as decrease in the explosive dynamic leg muscle strength are observed at the last 15 s period while experiment groups use these muscles at high levels in the first 15 s period (Table 5). Related literature state that stimulating ability of the exhausted fibrils decrease and cramping power reduces [2,12,21].

VC, FVC, FEV_1, FEV_1/FVC (%), FEF_{25-75}, PEF and MVV parameters of respiratory functions measured spirometrically give information on the lung respiratory capacities of the subjects. In this study, significant correlation between WT parameters and respiratory functions have been determined as seen in the linear regression analysis done to find the relation level between WT power parameters and respiratory functions (Tables 3-6). This finding shows the correlation between the oxidative energy sources and Wingate test. The contribution of oxidative energy sources during Wingate test has been estimated by various investigators and found to range from 13 to 40 % of the total energy expenditure, depending on the individual mechanical efficiency [18,23]. Our results are consistent with study of Counil *et al.* [9]. Briefly Counil *et al.* [9] have investigated anaerobic capacity in children with bronchial asthma by using wingate test. Counil *et al.* [9] have found that the children with asthma exhibited lower peak, mean power and anaerobic energy release in comparison with control subjects. In addition to this, finding shows the correlation between the maximum use of muscle power and namely anaerobic capacity and respiratory capacities. That is use of respiratory capacity and powers throughout all WT test periods prove that body supports muscle strength performance compatible with the circulation.

When the correlation between WT power values recorded in every 5 s and VC, FVC, FEV_1, FEV_1/FVC (%), FEF_{25-75}, PEF and MVV respiratory functions are examined, VC that shows the strength of respiratory muscles most clearly at the first (r:0.602) and sixth (r: 0.599) 5 s periods gives low r score, whereas gives higher r score at the s (r: 0.657), third (r: 0.666), forth (r: 0.678) and fifth (r: 0.617) 5 s periods (Tables 5 and 6). This clarifies that leg muscles do not need to use sufficient VC capacity in the first 5 s of WT test and in the last 5-s period, exhausted muscles do not use the VC capacity fully. It creates the feeling that VC is used in the maximum level during interval periods. Linear relation levels seen in regression curves of Fig. 1a also support that. However, no significant relation between fatigue index (AFI %) and VC as well as other measured respiratory functions has been found (Fig. 1b, Table 4). This can be due to three reasons; first, subjects are not sufficiently motivated; s, leg muscle cramps use isometric and isotonic cramps during WT, while they do not keep isokinetic cramping that is maximal cramping speed at the fixed speed and lose it; thirdly, anaerobic fatigue index (AFI) display an overall % low accountability coefficiency [7].

To protect and develop muscle power of sportsmen is an important problem to be handled by trainers and coaches. Experienced trainers and coaches unwilling to face these kinds of problems, try to work on the potential weak muscles where muscle strength differences come out in order to prevent any possible problem.

Because, the most important protective factor to prevent the in-season sport injuries is to strengthen the weak muscles of sportsmen out of season. Accordingly, anaerobic capacity, respiratory capacity and power characteristics of the lungs are among the most important criteria of sports performance. Therefore, respiratory muscles should overcome both the resistance that occurred due to air flow in the respiratory passages and elastic contraction of lungs and chest cavity.

In conclusion, spirometric respiratory functions tested in this study play an effective role in the WT power parameters. It can be concluded that there exists a significantly high positive correlation between VC, FVC, FEV_1, FEV_1/FVC (%), $FEF25_{-75}$, PEF, MVV and WT parameters both in trained and untrained sportsmen.

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Accepted for publication 21.11.2006

Acknowledgements

This work was presented in The 10th ICHPER-SD Europe Congress and The TSSA 8th International Sports Sciences Congress as a poster presentation at November 17-20, 2004, Antalya-Turkey