Evaluation of the Lung Diffusing Capacity for Carbonmonoxide (Dlco) in Healthy Male Teenagers in Relation To Physical Activity

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Abstract:
Intensive research work has been conducted on lung function changes during exercise, however, little is known about the influence of physical activity on the resting lung function especially in younger age group. The present study involved (25) healthy male teenagers (13-19 years) with body height(170±5.9 cm) and body weight(63±10.23 Kg).Lung volumes(VC and TLC), ventilation($FEV_{1\%}$ and $MMEF_{25-75\%}$) and diffusion parameters (DLco and DLco/VA) were measured by computerized spirographic , helium dilution and carbonmonoxide single-breath techniques.
All tested lung function parameters except, lung diffusion per unit lung volume (DLco/VA), had increased significantly with higher level of daily physical activity. The observed increase in the resting lung diffusion seemed to be related to the increase in lung volume brought about by higher physical activity rather than to changes in lung diffusing capacity per unit of lung volume (DLco/VA). The effect of cigarette smoking habit on lung diffusing capacity was evaluated. In conclusion, physical activity has a definite beneficial effect on resting lung diffusion, an effect which seemed unopposed by mild cigarette smoking

Key words: PFT, DLco, adolescence, physical activity.

Introduction

The beneficial effect of Physical activity on pulmonary function has been reported by many cross-sectional studies [1,2]. In the Amsterdam Growth and Health Studies, physical activity was observed to be positively correlated to changes in the forced vital capacity (FVC) between ages 13-27 year over a period of 15 years [3]. However, little is known about the influence of physical activity on lung diffusion especially in the younger age groups. The present study was conducted to evaluate the effect of daily habitual physical activity on the lung diffusing capacity for carbonmonoxide (DLco) in adolescence age group. The effect of smoking habit has been considered as well.

Subjects & Methods

Twenty-five healthy adolescent boys aged 13-19 year were involved in the present study. Physical characteristics of the study group are shown in table (1).Participants were students of the intermediary and secondary Nursing schools (Al-Auruba Nursing School for boys).

The studied group was enquired about habitual daily physical activity as well as smoking habits in addition to thorough physical examination to exclude pulmonary, cardiac or any acute illness at the time of testing which might interfere with the pulmonary function tests.

Subjects were grouped according to the level of daily physical activity and smoking habits into:

1-Control group (13 subjects): included subjects with usual level of daily physical activity.
2-Test group (7 subjects): included subjects with higher level of daily physical activity through practicing some sort of sports or participating in active jobs which require higher level of muscular activity.
3-Smokers group (5 subjects): included subjects with higher level of daily physical activity who regularly smoked cigarettes at least for 6 months with a smoking intensity of 5-10 cigarettes/ day.

The mean pack/year value for the smokers group was 0.5(mild smokers).Pack/year value represents the number of packs smoked per day multiplied by the number of years of smoking.

The study was conducted in the pulmonary function lab. /Baghdad Teaching Hospital/Medical City.

Subject testing was performed between 10 a.m. and 12 p.m. Room temperature varied between 22-27degree centigrade. Spirometry and DLco were performed by a computer based automated system (Master Lab Pro –version 4.3 from JAEGER-Germany).The apparatus consisted of a spirometer, computer and gas analyzers for carbon monoxide and helium. All indices were recorded at ATPS but automatically corrected for (BTPS) except alveolar volume (STPD).

At least three vital capacities were obtained in each subject, and the highest one was taken automatically as the representative vital capacity.

Forced vital capacity, percent vital capacity and maximum mid-expiratory flow rate were measured by flow/volume loops as described by Cogswell et al [4].

All calculations were done automatically by computer.

PFT included:
1-Forced vital capacity (FVC).

Test procedure was carefully explained and demonstrated for subjects before the test. Pulmonary function tests (PFT) were performed in a sitting position with nose clips and breathing through a mouthpiece of the spirometer.
2-Percent vital capacity (FEV1%).

Table 1: Physical characteristics of the study groups.

Parameter	Control group n=13	Higher physical activity group n=7	Smokers with higher activity n=5	P-value
Age (year)	16.8±2.06	17.4±1.27	17.0±1.0	**NS**
Height (cm)	169±6.4	173.0±5.41	168.2±4.71	**NS**
Weight (Kg)	61.6±11.2	66.71±11.58	61.4±4.21	**NS**
B.S.A. (m^2)	1.64±0.20	1.77±0.16	1.63±0.04	**NS**

- **Values represent the mean ± SD.**

Table 2: pulmonary function parameters compared between control and the higher physical activity groups.

Parameter	Control group (n=13)	Higher physical activity group (n=7)	P-value
DLco(ml/min/mmHg)	28.74±5.83	35.85±4.77	P<0.01
DL/VA (ml/min/mmHg/L)	1.87±0.10	1.80±0.14	NS
FVC (L)	4.03±0.74	4.87±0.87	P<0.05
$FEV_{1\%}$	84.38±4.61	89.14±4.74	P<0.05
$MMEF_{25-75\%}$ (L/S)	3.57±0.49	4.57±0.77	P<0.01
TLC (L)	5.36±1.12	6.65±0.94	P<0.01

- **Values represent the mean±SD.**

The influence of smoking habit on the positive relationship between physical activity and lung function tests is shown in table (3).Higher level of physical activity maintained a positive effect on all tested pulmonary function parameters in spite of cigarette smoking.

The lung diffusion capacity for carbonmonoxide (DLco) was significantly higher ($P<0.05$) in smokers with higher level of physical activity while the lung diffusion per unit lung volume (DLco/VA) was not significantly different.

The lung volume parameters (FVC and TLC) and the ventilation parameters $FEV_{1\%}$ and $MMEF_{25-75\%}$ increased significantly ($P<0.05$) in the smokers group with higher level of daily physical activity when compared with the control group with the usual level of daily physical activity.

Figures 1 and 2 demonstrated the increase in DLco and TLC in the higher physical activity group. Similar changes were obtained with the smokers group (figures 3 and 4).

Table 3: pulmonary function parameters compared between control and smokers groups.

Parameter	Control group (n=13)	Smokers group (n=5)	P-value
DLco(ml/min/mmHg)	28.74±5.83	35.0±4.12	P<0.05
DL/VA (ml/min/mmHg/L)	1.87±0.10	1.8±0.15	NS
FVC (L)	4.03±0.74	4.96±0.54	P<0.05
$FEV_{1\%}$	84.38±4.61	91.00±6.92	P<0.05
$MMEF_{25-75\%}$ (L/S)	3.57±0.49	4.30±1.00	P<0.05
TLC (L)	5.36±1.12	6.54±0.55	P<0.05

Values represent the mean±SD

Discussion

1-Effect of physical activity on lung diffusing capacity

The present study was restricted on male teenagers because, for social reasons, it was difficult to find teenager girls who practice any sort of sports to be involved in the present study.

The beneficial effect of exercise on health has been well recognized [7,8] however, little is known about the effect of physical activity on lung function and more specifically on lung diffusion in the younger age groups. In the present study, the age and body size parameters (height, weight, and body surface area) of participants were comparable for the different subgroups; the controls, the higher physical activity and the smokers groups (table 1).Because of their direct influence on lung function, age and body size matching is very necessary before any comparison could be made between different subgroups.

Data shown in table (2) demonstrated a significant increase($P<0.01$) in the lung diffusing capacity for carbonmonoxide (DLco) with increasing level of daily physical activity through practicing some sort of sports or working in a heavy job. Increased DLco with physical activity seemed to be related to the concomitant increase in lung volume (TLC) which was significantly higher ($P<0.01$) in the higher physical activity group when compared to the control group with usual level of daily physical activity. This finding is consistent with that reported by Robins et al (1995) which had demonstrated that young people who regularly perform aerobic exercise develop larger lung volumes[9].On the other hand, lung diffusion per unit lung volume (DLco/VA) seemed unrelated to the observed increase in lung diffusion since it was not significantly changed with increasing the level of physical activity(table 2).The present study data had also demonstrated a significant increase of the ventilatory parameters ($FEV_{1\%}$ and $MMEF_{25-75\%}$) in the higher physical activity group(table 2) which is in agreement with a study conducted by Wang et al (1993) who had demonstrated that during childhood and through adolescence, the lungs grow in proportion to the increase in body height. This growth results in an exponential increase in lung volumes and maximum flow rates with each year from preschool age through adolescence [10].

Physical training has been shown to enhance pulmonary function by increasing muscular strength [2, 11], improving cardiovascular performance [12, 13] and reducing obesity [14].

Physical exercise has also been found to prevent premature death [5] and promote longevity [7].

It is possible that increased physical activity, by increasing the power of the inspiratory muscles or by altering the mechanical properties of the chest wall, increases vital capacity by increasing the total lung capacity [15].Thus athletes might be expected to have greater vital capacity than nonathletes [16].

2- Effect of smoking on lung diffusing capacity

The harmful effect of cigarette smoking on lung functions has long been recognized through an intensive research work. However, there is little knowledge about the effect of smoking in relation to physical activity.

In the present study, smokers were asked to stop smoking for at least four hours before testing in order to minimize the COHB level according to the recommendations by the American Thoracic Society (ATS,1995) [17], furthermore, as we have utilized the single-breath technique for determining the pulmonary diffusing capacity, in which the inspired breath is held for 10 seconds only, the partial pressure of carbon monoxide in the blood is probably insignificant and may be disregarded since insufficient time is allowed for equilibrium to occur between alveolar carbon monoxide concentration and the carbon monoxide in mixed venous blood [18].

Although early investigators had failed to demonstrate an effect of smoking on lung diffusing capacity for carbonmonoxide[19,20] however, lower DLco values had been reported by a number of subsequent studies with an average decrease of approximately 3.9 ml/min/mmHg [21,22].

In the present study, such DLco decrease by smoking was not recognized in the physically active smokers group presumably because of the concomitant positive effect of physical activity on lung diffusion [22]. Data given in table (3) had clearly demonstrated a significant increase in lung diffusing capacity for carbonmonoxide ($P<0.05$) in the smokers group with higher level of physical activity while there were no significant difference in the lung diffusion when corrected for lung volume (DLco/VA).

Gold et al in 1996 had studied the effect of cigarette smoking on the level and growth of lung function in a cohort of adolescent boys and girls 10 – 18 years of age examined annually between 1974 and 1989 in six cities in the United States. Results revealed lower level of both $FEV_{1\%}$ and $MMEF_{25-75\%}$ with a dose response relation [23]. In the present study, such decline in the $FEV_{1\%}$ and $MMEF_{25-75\%}$ was not demonstrated presumably because of the concomitant effect of physical activity on lung function which had obscured the detrimental effect of smoking.

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