Influence Of Smoking And Physical Activity On Pulmonary Function
A Rexhepi, B Brestovci

Abstract
The purpose of this study was to examine the influence of smoking and physical activity on lung function. There were used the research method of three groups: smokers, non-smokers and sportsmen. Nine spirometric variables were used to evaluate the pulmonary function and differences between groups. Significance of the differences was tested by ANOVA and Canonical Discriminant Analyses. Sportsmen had significantly higher values of forced expiratory volume in 1st second and expiratory vital capacity, whereas the smokers lower. Non-smokers and sportsmen had similar lung capacity, but better than smokers. Factor Analyses had revealed two latent factors. The first factor explained 64.9% of the total variance and inform about lung capacity. The second factor explained 12.96% of the total variance and inform about air-flowing during respiration. The differences between groups in latent structure were significant. This investigation revealed the effects of smoking and physical activity on decreasing, respectively increasing of respiratory abilities.

INTRODUCTION
Most people know that smoking is one of the main risk factors for a number of chronic diseases, including cancer, lung diseases, and cardiovascular diseases. Moreover, inhalation of smoke from even a single cigarette has been shown to cause brief broncho-constriction in both smokers and non-smokers. The reduction in specific conductance of the airways as the acute effect of smoking has been reported to be within 8 seconds after starting smoking, whereas the maximum acute effect 30 minutes after smoking. Smoking of tobacco significantly reduces the cardio-respiratory functions.

Smoking kills around 114 000 people in the UK each year, whereas the WHO reported that in 20th century tobacco smoking killed 100 million people, it is supposed that in 21 century could kill 1 billion people around the world. Despite this, it is common throughout the world. One who has smoked as much as one cigarette per day for long as one year has been defined as a cigarette smoker.

Medical researches had determined that chronic tobacco smoking can lead to many health problems, particularly lung cancer, emphysema, and other cardio-respiratory diseases.

Several cross-sectional studies have reported that physically active adolescents and those who participate in sports are less likely to be regular smokers compared to sedentary youths. Encouraging participation in sports has been widely recommended for smoking cessation programs.

In the assessment of lung function the spirometric measures are most commonly used. The spirometric variables are influenced by a number of external and internal factors (particularly sex, height, age, usual habitat, geographic condition, ethnic and racial origin, etc).

In principle, never-smoking entities who presently participate in team sports have marginally higher values of spirometric variables and maximal oxygen uptake (VO2max.abs. & VO2max.rel.) than those who do not. Smokers record lower scores for forced vital capacity (FVC) and forced expiratory volume in the 1st second of exhalation (FEV1) than non-smokers. Whereas several studies have reported that the smokers with moderate to high level of regular physical activity were associated with lower pulmonary function decline compared with physical inactivity smokers.

The purpose of this study was that through comparison of spirometric measures between smokers’ group, non-
Influence Of Smoking And Physical Activity On Pulmonary Function

smokers’ group and sportsmen group, to examine the influence of smoking and exercise on lung function.

MATERIAL AND METHODS

This research is the part of the project: “Influence of tobacco on pulmonary function” realized by the Institute of Sports Anthropology and Center for Sports Medicine and Recreation in Prishtina – Kosova.

To realize the intention of this study there was used the research method of three groups: smokers' non-sportsmen group (15 entities), non-smokers' non-sportsmen group (16 entities) and non-smokers sportsmen group (69 entities). The treated entities were aged 20 – 35 years old. The smokers’ entities who smoked more than 10 cigarettes daily for longer than one year were chosen. The smokers treated during this study smoked average 30 cigarettes per day (min=10 cigarettes/day, max=60 cigarettes/day). At the time of this study the smokers did not make any complain about their health status and their physical examination was without any pathological sign. All subjects completed the study without any complication. The non-smokers’ entities were chosen randomly, whereas the sportsmen entities were soccer players from the first and the second level of the competition of Kosova. The treated entities were inhabitants of Kosova. They were selected respecting rules that their psycho-physic status was in normal (free of psychiatric and cardio-respiratory acute or chronic symptoms of diseases, somatic status without any deformation) and similar ages. The entities who supposed to be exposed to harmful environmental factors were not included in this study. The spirometric measures have been performed by a computer-based pulmonary function analyzer QUARKPFT, with hardware and software in accordance with American Thoracic Society (ATS) and European Respiratory Society (ERS) recommendations.

The measurements are done in the Center of Sport Medicine and Rehabilitation in Prishtina, during the period 2004 – 2005, the measurer was the first author of this study.

Nine spirometric measures (variables) were used to evaluate the pulmonary function of the treated groups:

- Forced Vital Capacity (FVC);
- Forced Expiratory Volume in 1st second (FEV1);
- Inspiratory Vital Capacity (IVC);
- Expiratory Vital Capacity (EVC);
- Peak Expiratory Flow (PEF);
- Peak Inspiratory Flow (PIF);
- Expiratory Reserve Volume (ERV);
- Inspiratory Reserve Volume (IRV);
- Maximum Voluntary Ventilation (MVV).

Statistical analysis was performed using SPSS statistical software (version 15.0). Results of descriptive statistic were expressed as mean (X), minimal (Mini) and maximal (Maxi) values, as well and standard deviation (SD). Analysis of the variance (Anova) and test of multiple comparisons (Tamhane) were used to assess differences in manifest and latent structure between three treated groups. P values minor than 0.05 were considered statistically significant. The Canonical Discriminant Analyses was used to find out the characteristics of the treated groups, respectively to show the variables that best discriminate the study groups. The latent structure of the measured manifest spirometric variables has been analyzed by the Factor Analyses.

RESULTS

Descriptive results of spirometric pulmonary functions are summarized in Table 1. Mean values of these spirometric measures were higher in non-smokers than in smokers, and highest in sportsmen entities.
The significance of systematic differences between three groups in each spirometric variable, shown in Table 1, was tested by Analyses of Variance – Anova (Table 1). Results of Analyses of Variance showed that the differences between three groups in each variable were significant (Sig < .01).

The results of multiple comparisons, shown on Table 2, proved the differences between each groups in each measured variable. Significant reciprocal differences between three treated groups were realized in two measured variables: FEV1 (forced expiratory volume in 1st second) and EVC (expiratory vital capacity). Non significant differences between smokers and non-smokers were found on these variables: PEF (peak expiratory flow), PIF (peak inspiratory flow), ERV (expiratory reserve volume), IRV (inspiratory reserve volume) and IVC (inspiratory vital capacity); Non significant differences between non-smokers and sportsmen were found on FVC, PEF, PIF and ERV. In all measured spirometric variables the differences between smokers and sportsmen were significant.
By the Canonical Discriminant Analyses were tested the significance of the multidimensional differences between three treated groups and were shown the variables that best discriminate the study groups (Table 3, 4 and 5). Through this statistical method were extracted two canonical discriminant functions (Table 3), but only the first discriminant function (Sig = .000) significantly discriminate three treated groups and could be used for interpretation of
structure matrix (Table 4) and group centroids (Table 5).

**Figure 6**

TABLE 3 – Summary of canonical discriminant functions

<table>
<thead>
<tr>
<th>Function</th>
<th>% of Variance</th>
<th>Cumulative %</th>
<th>Re</th>
<th>Wilks'λ</th>
<th>X²</th>
<th>df</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.605(*)</td>
<td>.605</td>
<td>.705</td>
<td>.447</td>
<td>66.651</td>
<td>18</td>
<td>.000</td>
</tr>
<tr>
<td>2</td>
<td>.125(*)</td>
<td>.125</td>
<td>.335</td>
<td>.889</td>
<td>9.373</td>
<td>8</td>
<td>.281</td>
</tr>
</tbody>
</table>

The results on Table 4 show structure of the first canonical discriminant function, respectively correlations between measured variables and extracted canonical discriminant function.

**Figure 7**

TABLE 4 – Structure Matrix

Arithmetic means of the discriminant values of the groups in relation with first discriminant function, which present groups centroids are shown in Table 5.

**Figure 8**

TABLE 5 – Function at Group Centroids

The latent structure of the measured manifest spirometric variables has been analyzed by the Factor Analyses (Table 6). Respecting the criterion of Gutman-Kaiser, the nine manifest spirometric variables have been reduced, respectively condensed on two latent factors with eigenvalue higher than 1.
The extracted latent factors explained 77.9% of the total variance. According to the results of Pattern Matrix (Table 6) the first latent factor, which explained 64.9% of the total variance, contained information about lung capacity and could be named as factor of lung capacity. The second latent factor explained 12.96% of the total variance and contained information about flowing of the air during respiration. This factor could be named as factor of respiratory flow rate. The correlation between two extracted latent factors (R=0.521) is significant at the Sig. <0.01 level.

The significant differences between groups regarding two extracted latent factors were analyzed by Analyses of Variance (Anova), whereas the multiple comparisons by Tamhane.

Results on the Table 7 showed the significant differences between groups in latent structure of the nine measured spirometric variables (two extracted latent factors). Multiple comparisons between groups, with regard to factor of lung capacity, showed non significant difference between nonsmokers and sportsmen. Whiles regarding to second latent factor (factor of respiratory flow rate) the significant differences where found only between sportsmen and smokers.

**DISCUSSION**

The results of this investigation show the influence of smoking on pulmonary function. Smoking of tobacco on smokers reduced all the mean values of lung function tests compared with non-smokers and sportsmen. Influenced by smoking, the small airways and parenchyma are primarily effected regions showing the pathologic changes in the lungs.

The data of descriptive statistics showed systematic differences between three groups in all measured variables (Table 1). The evaluation of the arithmetic means for three groups was made by Analyses of Variance. The results of Anova (Table 1) showed statistically differences between treated groups in each measured spirometric variable. The results of multiple comparisons showed on Table 2 proved statistically differences, respectively non-differences, between each group in each variable.

By the canonical discriminant analyses were identified the characteristics of groups and the variables which did the best discrimination between treated groups. The data from the
Table 3 showed significance of the discriminant functions. The data of the Table 4 and 5 identified the nature of the discrimination for each discriminant (canonical) function. According to these data could be proved that the spirometric variables which inform about lung ventilation abilities did the best discrimination between groups.

Among three tested groups, sportsmen had significantly higher values of forced expiratory volume in 1st second (FEV1) and expiratory vital capacity (EVC), whereas the daily smokers had significantly lower FEV1 and EVC. Non-smokers (FVC=5.33 L) and sportsmen (FVC=5.71 L) had similar lung capacity, but much better compared with those who were daily smokers (FVC=4.60 L). The lower FEV1, FVC and EVC values of the smokers compared with other two nonsmokers groups could be presumed due to involvement of smaller airways obstruction \(^{13,14}\). These results indicated that the smokers had developed some degree of lung function impairment in relation to nonsmokers and sportsmen \(^{5,19}\).

The significant differences between smokers and nonsmokers could be explained with the functional and structural abnormalities that smoke cause on terminal bronchioles (mucus plugs, accumulation of pigment laden macrophages, goblet and squamous cells metaplasia, ulceration, inflammatory cell infiltrate, smooth muscle hypertrophy, fibrosis and excessive pigments) \(^{5,13,19}\). The significant differences between sportsmen and other two treated groups proved the influence of physical activity on improvement of cardio-respiratory functions, respectively increasing of their values.

Because the medical scientific researches have interdisciplinary character, it’s necessary that during investigations to be included an optimal number of represent manifest variables. Many times for a good explanation, prediction or transformation of the medical scientific problems it’s not enough just exploration of the manifest structure of those problems. The latent structure of those scientific problems might contained many underhandled information that could be revealed using the mathematics and statistics procedures of Factor Analyses. So, the exploration of the latent structure is the scientific imperative. The latent structure of nine measured spirometric variables, in the case of our research, has been explored by Factor Analyses. Principal component factor analysis revealed that the above mentioned data could be reduced to two hypothetical latent variables (factors), which explained 77.9% of total variances. Because the first latent factor contained mostly the variables that informed about lung capacity and explained 64.9% of the total variance was named as factor of lung capacity. Whereas the second latent factor contained the variables that informed about the flowed of the air during respiratory phases and explained 12.96% of the total variance was named as factor of respiratory flow rate.

Differences between three treated groups regarding the latent structure of nine measured spirometric variables were significant.

The present investigation, studying the differences between smokers, nonsmokers and sportsmen subjects, revealed the effects of smoking on lung function, as well and influence of physical activity on increasing of respiratory abilities.

The values of spirometric variables presented in this study for the smokers, non-smokers and sportsmen subjects might be helpful for the estimation of lung function of a given subjects, for detection of eventually obstructive pulmonary diseases, for the assessment of severity of these diseases, and for the assessment of degree of pulmonary dysfunction as a result of influence of smoking.

**References**

Influence Of Smoking And Physical Activity On Pulmonary Function

8 of 9

Author Information

Agron M. Rexhepi, MD, PhD
Center of Sport Medicine and Recreation

Behlul Brestovci, PhD
Faculty of Special Education and Rehabilitation, University of Zagreb