



PULMONARY FUNCTION TESTS IN WORKERS EXPOSED TO ASBESTOS DUST IN RELATION TO SMOKING AND BODY MASS INDEX

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ABSTRACT

OBJECTIVE: To estimate the dependence of expiratory flows in asbestos exposed workers to body mass index and duration of smoking. **MATERIALS AND METHODS:** Spirometric tests using SPIROBANK (Italy) were performed among 97 healthy male workers, divided into groups according to their body mass index and smoking status. **RESULTS:** Statistically significant differences between non-smokers and smokers with 10 and more pack years were found for FEV₂₅₇₅ (p = 0.003), FEV₂₅ (p = 0.003), FEV₅₀ (p = 0.004) and FEV₁/FVC (p = 0.022). Using regression analysis, significant reverse correlation between pack years and the measured %pred was established for FEV₁, FEV₂₅₇₅, FEV₂₅ и FEV₅₀. No correlation between the measured expiratory volumes and body mass index or age was found. **CONCLUSION:** Smoking is a leading factor for the decreasing expiratory parameters recorded among the surveyed workers and it affects mainly the “small airways” expiratory flows, more pronounced in longtime smokers.

Key words: spirometry, smoking

INTRODUCTION

The Forum of International Respiratory Societies (FIRS), convening at the 40th Union World Conference on Lung Health in Cancun, Mexico on 6 December 2009, recognizes that hundreds of millions of people around the world suffer each year from treatable and preventable chronic respiratory disease. Chronic respiratory diseases cause approximately 7% of all deaths worldwide and represent 4% of the global burden of disease. Therefore FIRS declares 2010 as The Year of the Lung (1). The Forum recognized that tobacco use remains legal, although it kills more than 5 million people each year, including 1.3 million who die of lung cancer, and it affects the health of hundreds of thousands of others who are exposed to its effects secondhand. In addition nearly half of

the world's population lives in or near areas with poor air quality.

Parallel with that The European Respiratory Society (ERS) and the European Lung Foundation (ELF) declared October 14, 2010 as The First Ever World Spirometry Day.

Provoked by the mentioned above initiatives, the authors decided to perform spirometric tests among workers occupationally exposed to asbestos and living in the area with recognized atmospheric pollution.

The functioning of the respiratory system and consequently the expiratory flows determined in spirometry depend on individual characteristics like age, sex, height, weight and race.

Presence of smoking and its duration, intensity and onset influence significantly the respiratory function. Anthonisen N.R. et al. (2002) in an 11 year prospective study found a significant reduction in respiratory volumes in smokers compared to non-smokers (2). The more intensive the smoking combined with an early onset results in a significant reduction of respiratory volumes (3). Stavem K. et al. (2005) determined that FEV₁ associated with

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other respiratory volumes was a prognostic factor in the total and respiratory mortality in smokers and ex-smokers but wasn't related to mortality in non-smokers (4).

Obesity (BMI 30 kg/m² or greater) could be another risk factor for respiratory function disorders. Bottai M. et al. (2002) reported that lower values of FVC and FEV1 in the general population were linked to an increased BMI and after a weight reduction the respiratory parameters had improved (5). Ditsch K.A. et al. (2006) found decreased FVC in asthmatic patients with obesity compared to non-obese patients(6).

Spirometry is the most comprehensive screening method for chronic lung diseases, including those of occupational aetiology. FVC, FEV1 and FEV1/FVC (Tifno) are the most important indicators in the diagnosis of obstructive and restrictive functional changes. FEV50 and FEV2575 give information about the disorders. FEV1/FVC and FEV2575, and to a lesser extent FEV1, change more significantly as a result of cigarette smoking (7).

The main objective of the study was to estimate the dependence of expiratory flows in asbestos exposed workers to body mass index and duration of smoking (calculated in pack years).

MATERIALS AND METHODS

Ninety seven male workers exposed to mixed dust containing asbestos fibers were examined. Asbestos levels measured at different working operations were variable – ranging from 0.02 to 1.02 fibers/cm³ (permissible exposure level for asbestos is set at 0.1 fibers/cm³). All workers were routinely required to use personal protective equipment (PPE) for the

respiratory organs. The average age of the subjects was 36.5 ± 11.2 years. The workers were questioned on duration of their smoking and number of smoked cigarettes per day, which were then calculated in pack years. None of the subjects had any record of chronic respiratory diseases. Body mass index (BMI) was calculated using the internationally approved formula.

According to smoking habits the workers were distributed into four groups (non-smokers - 28; smokers with less than 10 pack years - 22; smokers with 10-19 pack years - 20; smokers with 20 and more pack years – 27). And according to BMI the workers were divided into three groups: of normal weight - 54; overweight - 29; obese class I – 14 employees. Pulmonary function tests were performed using SPIROBANK (Italy). Respiratory parameters were measured as percent from the predicted normal values for each subject's age, height and weight (%pred). Tifno index (FEV1/FVC) was also calculated. Statistically significant difference was sought between groups divided according to smoking history and BMI for the following parameters: FVC, FEV1, PEF, FEV2575, FEV25, FEV75, FEV50, FEV1/FVC. Correlation analysis was performed to determine a possible dependence of the expiratory parameters to pack years, BMI and age.

RESULTS

The measured expiratory flows in different smoking groups are presented in **Table 1**. The mean values of %pred for all investigated expiratory parameters were under 100 (predicted normal values according the age, height and weight).

Table 1. Mean %pred of spirometric parameters in different smoking groups

Parameters	Non-smokers (n=28)	Less than 10 pack years (n=22)	10-19 pack years (n=20)	20 pack years and more (n=27)	Smokers total (n=69)
FVC	92.08	94.07	93.87	91.05	92.83
FEV 1	93.69	94.45	92.64	88.82	91.72
PEF	89.63	82.70	91.09	82.22	84.94
FEV 2575	88.52	90.4	79.89	76.32	81.84
FEV 25	93.89	86.59	87.09	78.49	83.57
FEV 50	90.34	92.06	82.71	76.52	83.27
FEV 75	76.34	78.05	73.4	69.63	73.69
FEV1/FVC	86.59	85.79	82.13	83.67	83.9

Significant difference between smokers with 10-19 pack years and non-smokers, as well as smokers with less than 10 pack years was established for FEV2575, FEV1/FVC and FEV75. On the other hand, in smokers with 20 and more pack years was found a significant reduction in five expiratory parameters compared to non-smokers (FEV1, FEV25, FEV50, FEV2575, FEV1/FVC) and in four parameters compared to smokers with less than 10 pack years. No difference for all measured parameters was present between the group of

non-smokers and smokers with less than 10 pack years, as well as between smokers with 10-19 and smokers with 20 and more pack years (**Table 2**).

Smoking groups	Non-smokers	Less than 10 pack years	10-19 pack years	20 pack years and more
Non-smokers		no difference (p>0.05)	FEV2575 p=0.036 FEV1/FVC p=0.05	FEV1 p=0.045 FEV2575 p=0.004 FEV25 p=0.001 FEV50 p=0.003 FEV1/FVC p=0.05
Less than 10 pack years	no difference (p>0.05)		FEV2575 p=0.05 FEV75 p=0.02	FEV1 p=0.05 FEV2575 p=0.01 FEV50 p=0.01 FEV75 p=0.002
10-19 pack years	FEV2575 p=0.036 FEV1/FVC p=0.05	FEV2575 p=0.05 FEV75 p=0.02		no difference (p>0.05)
20 pack years and more	FEV1 p=0.045 FEV2575 p=0.004 FEV25 p=0.001 FEV50 p=0.003 FEV1/FVC p=0.05	FEV1 p=0.05 FEV2575 p=0.01 FEV50 p=0.01 FEV75 p=0.002	no difference (p>0.05)	

Table 2. Statistically significant differences in spirometric parameters between different smoking groups

This occurrence gave us a reason to compare the respiratory volumes in two generalized groups:

non-smokers and smokers with 10 and more pack years, which are presented in **Figure 1**.

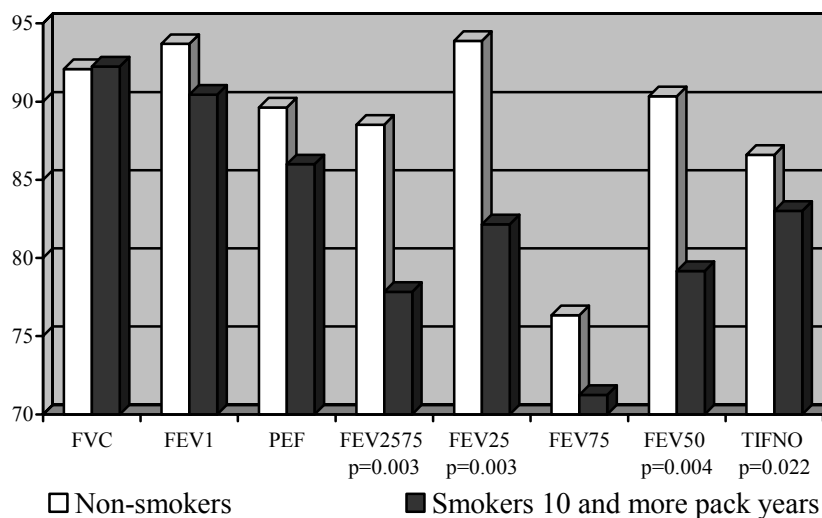


Figure 1. Mean %pred of respiratory parameters in non-smokers and smokers with 10 and more pack years

Statistically significant differences between the two newly formed groups were found for FEV₂₅₇₅ ($p = 0.003$), FEV₂₅ ($p = 0.003$), FEV₅₀ ($p = 0.004$) and FEV₁/FVC ($p = 0.022$).

Using regression analysis, significant reverse correlation between pack years and the measured %pred was established for FEV₁, FEV₂₅₇₅, FEV₂₅ и FEV₅₀ (**Figure 2**). Reverse dependency but no significant correlation was determined also for FEV₇₅ and FEV₁/FVC.

For the parameters PEF and FVC no correlation dependency with smoking (pack years) was present.

The results of the measured expiratory flows in different BMI groups are shown in **Figure 3**. No statistically significant difference was found between BMI groups in any of the studied parameters. There was no correlation between BMI and the measured respiratory volumes.

In addition, no correlation was present between age of the workers and the respiratory parameters set.

DISCUSSION

One of the most commonly used indicators of respiratory function, FEV₁, shows significant decrease with increased duration of smoking. A. Khan et al. (2010) in a study of 200 non-smokers and smokers with 7 - 10 pack years registered a slight decrease in FEV₁ (60-80% pred) in 8.5% of the subjects, all of which were smokers. Two thirds of the people with abnormal FEV₁ had the maximal for the study duration of smoking: 10 pack years (9). Similar to our research, D. Stav (2007) found correlation between FEV₁ and pack years ($r = - 0.24$) in smokers with 20 and more pack years aged 45-75 (10). The correlation between pack years and reduction in FEV₁ that we established was very similar: $r = - 0.21$ ($p = 0.04$).

Another popular indicator in the diagnostic practice is FEV₁/FVC. Khalid G. et al. (11) found reverse correlation between FEV₁/FVC and pack years ($r = - 0.66$). Seemungal T. et al. (12) performed spirometric tests to 720 patients admitted to the emergency unit. The tests showed that smokers had lower FEV₁/FVC than non-smokers and there was a reverse correlation between that parameter and pack years ($r = - 0.165$, $p < 0.001$). Goodman

L. et al. (2006) in a survey among patients with COPD recorded that pack years affected FEV₁/FVC in the whole studied group ($p = 0.0058$). There was a statistically significant difference between smokers and non-smokers in males ($p = 0.0489$) but not in females ($p = 0.2023$) (13). In our study, we found a difference between non-smokers and smokers with 10 and more pack years, and a reduction in FEV₁/FVC with the increase in pack years, albeit insignificant.

Unfortunately, most researchers use the above mentioned spirometric parameters: FEV₁, FVC and FEV₁/FVC. We could not find referential data for changes in other parameters in relation to smoking and BMI. Our study showed that smoking affects not only the standard three, but also other expiratory volumes: FEV₂₅₇₅, FEV₂₅, FEV₅₀, FEV₇₅.

The lack of correlation between BMI and the measured respiratory volumes, as well as the lack of statistically significant difference among the groups divided according to BMI could be attributed to the higher proportion of workers with normal weight (56 %) and overweight (30 %) compared to those with obesity (14% only). Ghabashi A.E. (2006) also finds no correlation between BMI and spirometric parameters in asthmatics(8).

The low variation in age (36.5 ± 11.2 years) of the studied workers explains the lack of correlation between age and respiratory volumes.

The individual characteristics as age and weight, that could influence respiratory function did not present themselves as causes for the decrease in expiratory volumes. All workers operated under the same working conditions and used personal protective equipment against dust exposure. Therefore, smoking was the main cause for the recorded alterations in breathing function.

The results of our study allowed for the following conclusions:

1. Smoking was a leading factor for the decreasing expiratory parameters recorded among the surveyed workers.
2. Smoking affects mainly the "small airways" expiratory flows - FEV₂₅₇₅, FEV₂₅, FEV₅₀, FEV₇₅, FEV₁ and FEV₁/FVC, which showed reverse correlation with duration and intensity of smoking.
3. The registered decrease in expiratory flows was most pronounced in smokers with 20 or more pack years.
4. No significant difference in expiratory flows was present between non-smokers and smokers with less than 10 pack years.

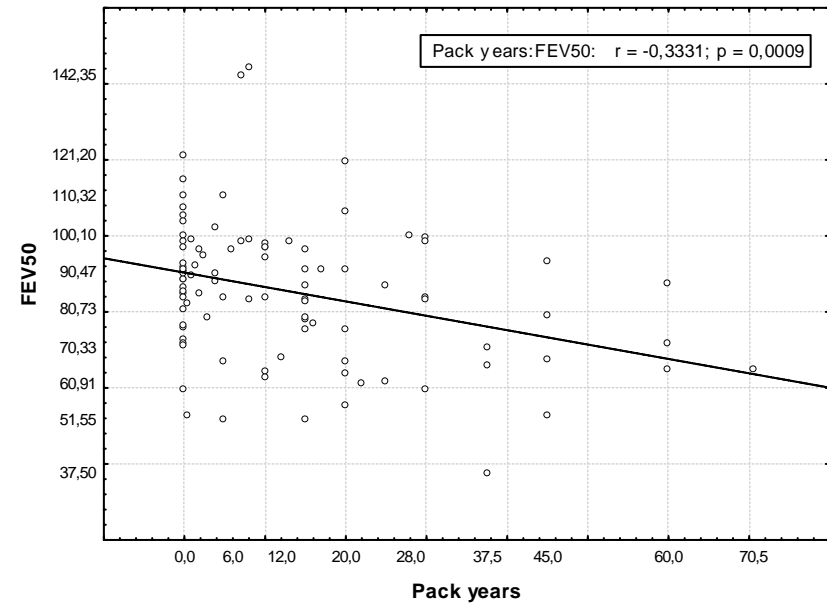
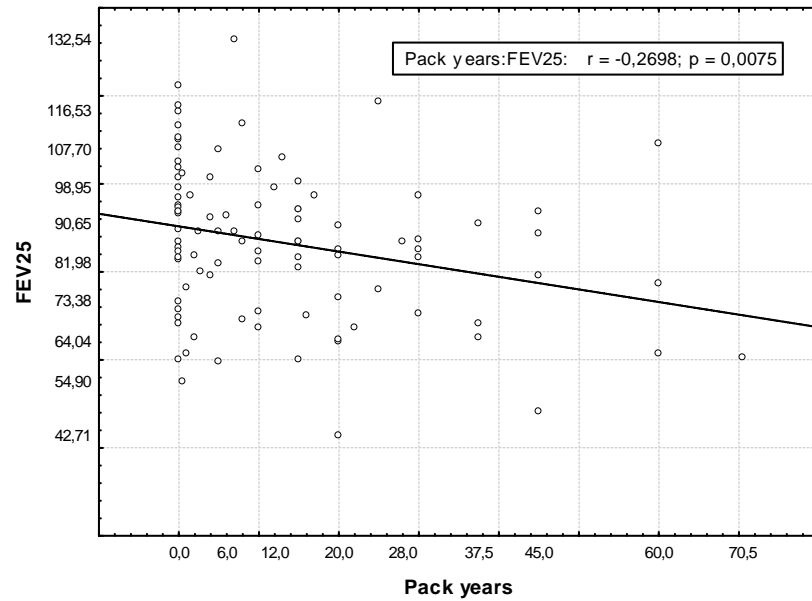
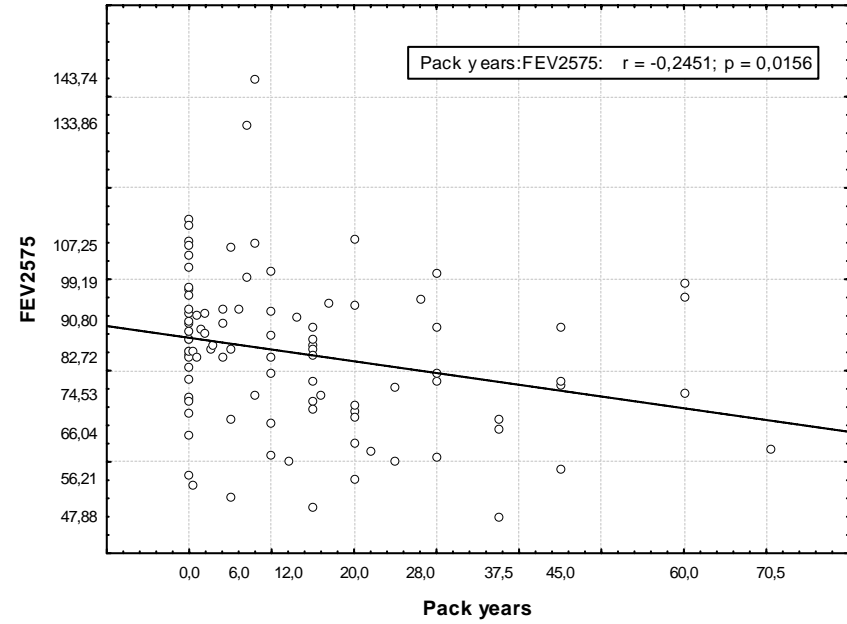
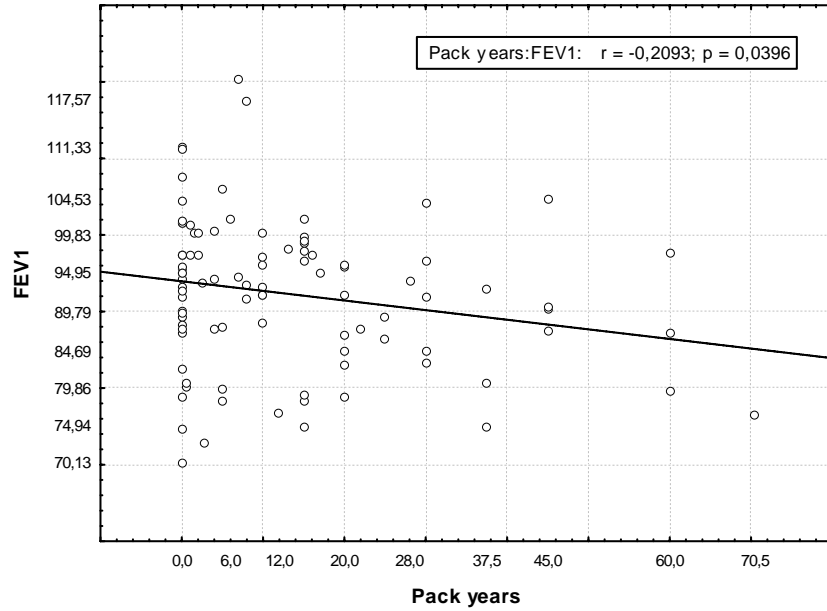
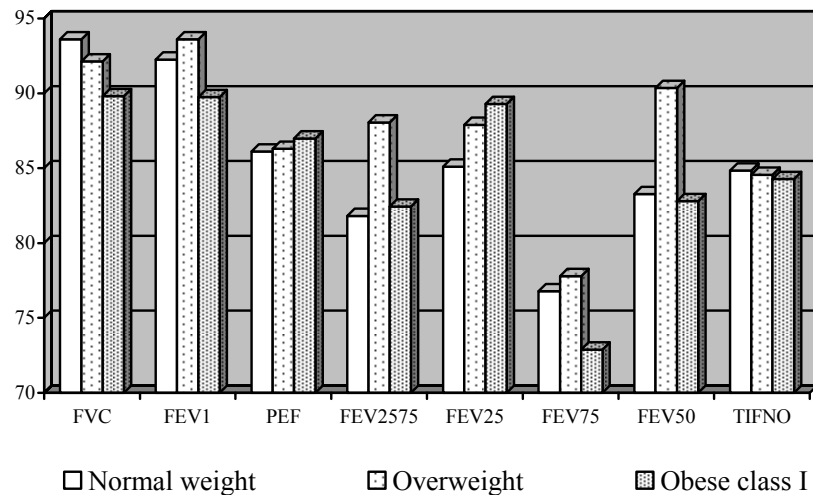


Figure 2. Significant correlation between some respiratory parameters and smoking (pack years)**Figure 3.** Mean %pred of respiratory parameters in the groups divided according BMI

In addition, the current study showed that smoking remains an undeniable cause for decline in the respiratory function. Therefore Bulgaria, as a ratifying state at the WHO Framework Convention on Tobacco Control (14) should enforce not only price and tax measures to reduce the demand for tobacco, but also non-price measures, namely:

- Protection from exposure to tobacco smoke;
- Regulation of the contents of tobacco products;
- Regulation of tobacco product disclosures;
- Packaging and labelling of tobacco products;
- Education, communication, training and public awareness;
- Tobacco advertising, promotion and sponsorship;
- Demand reduction measures concerning tobacco dependence and cessation.

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