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Assessment of Chest and Postural Alignment in Healthy Turkish Coal Miners

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The purpose of this study was determination of healthy coal miner's chest and postural alignment. Tuncbilek Coal Mining Industry of Kutahya-Turkey, employed 816 worker selected 60 underground coal worker and 60 male subjects (15 office cleaner, 14 bus driver, 11 barber, 12 grocer and 8 casier) as a control group mached with age, height, weight the coal miner subjects. None of the subjects in the study had a history of pulmonary disease. Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1), FVC/FEV1 ratio, dynamic chest circumference and posture analyses were applied to all subjects. FVC and FEV1 values were observed statistically lower, FEV1/FVC ratio higher, smoking history longer and better postural alignment in healthy coal miners than control subjects ($p<0.05$). Healthy coal miners are under risk of obstructive lung diseases and smoking is impaired the lung function as effect as coal dust. Thoracic excursion and postural alignments are not affected in miners as in office cleaners, bus driver, casier, barber and grocers.

Key words: Coal miner, pulmonary function tests, postural alignment, chest circumference

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INTRODUCTION

Occupational exposure to coal mine dust can lead to the development of a spectrum of diseases including simple coal worker's pneumoconiosis, Caplan's syndrome, bronchitis, emphysema and silicosis[1]. The adverse respiratory health effects of occupational dust exposure have been extensively reviewed[2-4]. A series of early studies by the MRC Pneumoconiosis Research Unit in South Wales found significantly lower mean levels of indirect maximum breathing capacity in miners and ex-miners than in non-miners of the same age[5]. However, the explanation for the impairment of lung function in coal miners is controversial and no more studied are compared the thoracic excursion and spirometric tests in healthy miners lung and other occupations. Also, we have not met an investigation with related miners working in Tunçbilek Coal Mining Industry of Kütahya, Turkey. The purpose of this study was determined lung function, chest circumference and postural alignment in healthy underground coal miners.

MATERIALS AND METHODS

Subjects: When this study was done, the Tuncbilek Coal Mining Industry of Kutahya, Turkey, employed 816 underground and surface worker standard high-kilovoltage posteroanterior and lateral chest films at maximum inspiration were made for each worker every 2 year at the worker's yearly medical examination. These films were routinely read by the occupation physicians. First we selected 60 underground coal worker who had worked for 10 year or more (mean 17.73 ±3.9 year) at face work and had no known disease and chest XR findings. We then choose 60 male subjects (15 office cleaner, 14 bus driver, 11 barber, 12 grocer and 8 casier) as a control group worked in the same city (mean 16.8±5.8) and mached with age, height, weight of the coal miner subjects. None of the workers in the study had a history of pulmonary disease such as tuberculosis, pneumonia, lung cancer, etc. Lifetime smoking habits and occupational history were obtained from questionnaires and interviews. Informed written consents were obtained from all subjects.

Pulmonary function test: Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1) and FVC/FEV1 ratio were measured by BENNET portable microspirometer. All measurements were tested three times in standing position with the nose obstructed and best one of them was recorded.

Posture analyses: Anterior, lateral and posterior posture analyses were performed to all subjects. Chest abnormalities, rounded shoulder (anteriorly), kyphosis, lordosis, forward head (laterally) and scoliosis (posteriorly) were examined by using postural alignment board.

Measurement of dynamic chest circumference: Chest circumference was measured in 3 levels on the chest in standing position by tape. First we were assessed the inter/intra observer variability on 10 healthy subject than axillar, xiphoid and subcostal level's rest, full inspiration and expiration dynamic chest circumference were measured. Each measurement were repeated three times and best one to each was recorded[6-8].

Statistical analysis: Statistically analysis was performed with SPSS software (version 10.0, Chicago, USA). The inter- and intra-RO variability and standard deviation of dynamic chest circumference were calculated using output generated by one-way analysis of variance. Data are presented as means and standard errors. Significance of differences between the healthy coal miners group and the control subjects was determined by unpaired t test. A probability value of less than p =0.05 was considered significant. The population means and frequencies were calculated. Comparison of frequencies of postural malaligments and smoking habits between the different groups were made with the chi-square test or Fisher's exact test of probability.

RESULTS

No statistically differences were found between group's age, height, weight and BMI. Smoking duration was found statistically longer in coal miners than control subjects ($p<0.01$). The demographic characteristics of the controls and coal miners are presented in Table 1.

Table 1: Demographic Characteristics of Subjects*

	Groups	
	Healthy Miner (N: 60)	Control (N: 60)
Gender (M)		
Age (year)	42.7±2.8 (36-48)	42.8±7.2 (24-59)
Height (m)	1.70±0.7 (1.60-1.90)	1.7±0.6 (1.59-1.87)
Weight (kg)	78.6±11.1 (55-105)	77.3±9.7 (57-101)
BMI ($kg\ m^{-1}$)	27.1±3.6 (20-37)	25.6±2.9 (19-31)
Smoking status		
Duration (year)**	16.2±8.4 (1-40)	12.0±8.2 (1-25)
Pieces of a day	14.2±8.4 (6-35)	14.0±11.5 (10-40)

*$p>0.05$, ** $p<0.01$, Data are listed as mean±SD, BMI: Body Mass Index ($kg\ m^{-1}$)

Table 2: Pulmonary function test results

	Miner (N: 60)		Control (N: 60)		
Groups	Predict	Test (% predict)	Predict	Test (% predict)	p-value[a]
FVC, lt	4.3±0.5	3.7±0.7(%86)*	4.5±0.5	4.2±0.8(93.3)	<.05
FEV1, lt	3.6±0.4	3.2±0.6 (88.9)*	3.7±0.4	3.6±0.8(97.3)	<.05
FEV1/FVC (%)	79.8±0.8*	88.3±7.7*	80. 1±1.5	87.5±8.2	NS

NS: Non-significant, [a] To compare the group differences between the coal miner and the control group. *p<.05, within-group differences from predict to follow-up, Data are listed as mean±SD

Table 3: Evaluation of postural malaligments

Group	Miner (N: 60)	Control (N: 60)	P-value[a]
Forward head, N (%)	1(1.7)	7(11.7)	<.05
Barrel chest, N (%)	2(3.3)	1(1.7)	NS
Funnel chest, N (%)	0	1(1.7)	NS
Pigeon chest, N (%)	1(1.7)	0	NS
Kyphosis, N (%)	5(8.3)	6(10)	NS
Lordosis, N (%)	2(3.3)	3(5)	NS
Kypholordosis, N (%)	1(1.7)	4(6.7)	<.05
Round back, N (%)	2(3.3)	5(8.3)	<.05
Scoliosis, N (%)	4(6.7)	5(8.3)	NS

NS: Non-significant, [a]chi-square test was used to compare the group differences between the coal miner and the control group. Data are listed as mean±SD

Table 4: Measurement chest circumference*

Groups	Miner	Control
Axillary Level (cm)	89.4±6.3	99.5±6.3
Max. I-E Difference	5.3±1.4	5.7±2.1
Xiphoid Level (cm)	95.4±7.4	95.1±7.0
Max. I-E Difference	5.3±1.4	6.0±2.0
Subcostal Level (cm)	93.4±9.5	92.7±8.4
Max. I-E Difference	5.6±1.8	5.7±1.7

*p>0.05, I: Inspiration, E: Expiration, Data are listed as mean±SD

Pulmonary function test results: FVC and FEV1 values were observed statistically lower in coal miners than predict values and control subjects (p<0.05). FEV1/FVC ratio was found higher than predict values within both groups (p<0.05) (Table 2).

Postural analyses: Forward head, kypholordosis and rounded back as a postural malalignment in coal miners were observed statistically lower than control (p<0.05), but no statistical differences were observed between groups in chest abnormalities, scoliosis, kyphosis and lordosis. Scoliosis in both groups was found similar and functional wide "C" curve (p>0.05) (Table 3).

Chest circumference: No statistically differences were found between inter and intra measurements of chest circumference. In addition no statistically differences were observed between groups in three chest levels (p>0.05). Maximal inspiration and expiration differences were found similar (Table 4).

DISCUSSION

Coal dust significantly affect lung function and incidence of symptoms of underground miners. A series of early studies by the MRC Pneumoconiosis Research Unit in South Wales found significantly lower mean levels of Indirect Maximum Breathing Capacity (IMBC) in miners and ex-miners than in non-miners of the same age[5,9]. Another investigation in South Wales compared the respiratory health of miners from a single colliery with that of a control group of telecommunication workers from the same locality[10]. More of the miners than controls reported symptoms of chronic bronchitis (31% versus 5%) and their lung function also tended to be worse. Some 20% had a forced expiratory volume in one second (FEV1) less than 80% of that predicted for their age and height, compared with only 10% of the controls. This difference was apparent both in smokers and non-smokers. In Belgium, Nemery *et al.*[11] carried out a cross sectional comparison of 32 non-smoking coal miners and 34 non-smoking steelworkers. The miners had significantly lower FEV1 values and maximum expiratory flow rates and significantly higher residual volumes. More recently, Lewis *et al.*[12] compared FEV1 values in 1286 miners from seven collieries in the East Midlands of England who did not have pneumoconiosis on chest radiography with 567 men sampled at random from the residents of a local authority area in Nottingham. After adjustment for age, height and smoking, FEV1 was 155 mL (95% CI 74 to 236 mL) lower in the miners than in the controls, the difference being greatest in younger men. Individually, all of the studies that have addressed the relation of coal mining to lung function have limitations, but these vary from one investigation to another and often would tend to obscure rather than exaggerate any effect of dust. The balance of evidence points overwhelmingly to impairment of lung function from exposure to coal mine dust and this is consistent with the increased mortality from COPD that has been observed in miners[9].

The proportion of miners reported as having never smoked (53.8%) was surprisingly high, however, suggesting that there may have been some misclassification of their smoking in the analysis. If present, this misclassification would have tended to exaggerate any deficit of lung function in the miners[13].

Morgan[14] argued that, whereas susceptibility to the adverse effects of smoking varies markedly between persons with a minority developing severe impairment of lung function while many others are relatively unaffected, the loss of FEV1 caused by coal mine dust is distributed much more evenly and is almost always minor. He bases this theory in part on the observation that bronchitis is present in over 50% of non-smoking miners who have worked for 20 years or longer. Also, in a survey of 611 coal miners seeking compensation for "black lung" in the United States one non-smoker who, in the absence of other non-occupational respiratory diseases, had sufficient airways obstruction to make hard labour difficult[15]. Further clues may lie in the pattern of lung function deficit associated with dust exposure. There is some indication that the loss of FVC relative to FEV1 is greater from dust than from smoking. At present, however, the exact nature of the pathology underlying the loss of lung function in miners is still uncertain[16].

In this study healthy miner's FEV1 (10.1%) and FVC (10.6%) values were lower than control. However, these values were observed 80% predict values. These spirometric results were observed under morbidity effect. Healthy Miners were smoked longer than control subjects. Therefore, smoking can be effected the healthy miner's lung. Smoking as a single factor influenced ITGV, TLC and in borderline, FEF 25% FVC. Underground working time formed solely Raw, ITGV, RV and TLC. The additional effect of smoking and underground working time makes this influence much more significant[17]. Smoking and occupational exposure to dust generally are lead to additive changes towards bronchitis--related airflow limitation in the population. The expiratory flow decrease and intrathoracic gas volume increase seem to be sensitive parameters to detect early effects due to the influence of smoking and dust exposure[18].

Chest dimensions and pulmonary function are positively correlated in healthy individuals[19,20]. Classically chest circumferences have been used for assessment of thorax excursion[21]. Several pathogenetic factors, alone or in combination, may contribute to the increased frequency of respiratory complications in achondroplasia. Relatively small chest circumference sometimes may contribute in achondroplasia. Hunter *et al.*[22] reported that some preliminary data regarding the possible association of chest size with respiratory signs and symptoms. With men of all ages grouped, chest expansion of smokers was significantly lower than non-smokers, but their chest size and shape were similar. Measurement of chest circumference indicate that external chest dimensions of cigarette smokers reflect the pulmonary changes Borkan *et al.*[19] demonstrate that a portion of the increased variability in chest measurements seen in older individuals is attributable to cigarette smoking.

In our study showed that the measurement is the dynamic chest circumference by tape in three levels effective, reliable and useful test for to determined the thoracic excursion. In this study healthy miners were demostreted mean 5.3-5.6 cm in all levels thoracic excursion and control subject 5.7-6.0 cm, respectively. Thoracic excursion in healthy subjects was reported about 5-7.5 cm[7]. These results show that age, dust and smoking habits are not changed in dynamic chest movement. Plathow *et al.*[23] investigated that the diaphragm and chest wall motion during the whole breathing cycle using Magnetic Resonance Imaging (MRI) and a volumetric model in correlation with spirometry. Time-distance curves of the breathing cycle using MRI correlated highly significant with spirometry. VC calculated by the model was similar to VC measured in spirometry (5.00 vs. 5.15 L). Dynamic MRI is a simple noninvasive method to evaluate local chest wall motion and respiratory mechanics.

In our study, although no difference in dynamic chest motion between miners and control subjects, the spirometric test were decreased in miners. Rib cage is structured from intercostals muscles and costal bones. Thus, any problem in rib cage is performed restrictive lung disease (e.g. scoliosis, kyphosis.). In the other hand coal dust and smoking affected the lung tissue and may perform obstructive lung disease[24]. These results are show that the risk of obstructive lung disease higher than restrictive lung disease in miners.

Due to variations in the thickness of coal seams, there is great variability in the height of the roof where underground miners work. As the height of their workplace decreases, miners must stoop, duck walk, or crawl and their vision, posture and mobility become increasingly restricted [25]. Because of working in awkward postures in confined spaces were found significantly higher rates for osteoarthrosis at all ages among coal miners[26].

In this study, healthy miners was had better postural alignment than control subjects. Kypholordosis, rounded back and forward head postural malalignments due to control subjects occupations were observed higher than miners. Although miners work difficult physical conditions found no serious postural malalignment. In addition lifting, kneeling and digging activities strengthen the muscles of scapulotrhorasic region and back muscles. Further studies needs for assessment of miner's posture alignments by various methods. Gallagher *et al.*[25] studied about miners working postures and physiological results. Miners lifting capacity was averaged 11.3% lower when kneeling as compared to stooping. Heart rate was not significantly affected by posture, but was increased an average of 4 beats/min in asymmetric conditions and by 3.5 beats/min while lifting/lowering to/from the high shelf. Oxygen uptake was increased by 9% when stooped, by 10% when lifting lowering asymmetrically and by 8.2 % when performing the task to the high shelf [27]. In new study reported that the contribution of slips, trips and falls and increasing age of miners. The link between prolonged sitting, poor cab design and vibration with back and neck pain is being recognized but has yet to be addressed in any systematic way by the mining industry[28].

Consequently, healthy miners are under risk of obstructive lung diseases and smoking is impaired the lung function of miners as effect as coal dust. Thoracic excursion and postural alignments are not affected in miners as in office cleaners, bus driver, casier, barber and grocers.

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