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Function of respiratory system evaluated using selected spirometry parameters in persons occupationally exposed to lead without evident health problems

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ABSTRACT

This study aimed at evaluation of selected spirometric parameters in persons occupationally exposed to lead without evident health problems. The studies were conducted on 69 men occupationally exposed to lead. Occupational exposure to lead was characterized by estimation of blood lead concentration (Pb-B) and blood zinc protoporphyrin concentration (ZnPP). Function of respiratory system was examined using spirometric analysis with evaluation of its basic parameters: forced vital capacity (FVC), forced expiratory volume (in 1 s) (FEV1), Tiffeneau index (FEV1%VC) and peak expiratory flow (PEF). In the study group negative linear correlations were documented between Pb-B and FVC, FEV 1 and FEV1%VC. A more pronounced age, higher values of BMI and higher blood lead concentration constituted independent risk factors for reduced FEV1%VC.

Conclusion: Persons occupationally exposed to lead with elevated blood lead concentration and blood zinc protoporphyrin concentration manifested the impaired function of respiratory system, evaluated using parameters of spirometry.

1. Introduction

Occupational exposure to lead still is an epidemiological challenge in Poland. In years 2004–2005 in Poland the number of people working in exposure to lead was about 26,500, including worksites with lead concentrations exceeding Maximum Admissible Concentration (MAC), that is 3297 subjects. The number of employees working in settings where lead MAC is surpassed in Poland has moderately decreased; however, still is on the significant level: in 2011 – 2676 people, and in 2012 – the number was 2569. The majority of worksites where MAC was exceeded were connected with metals production (1700 in 2011 and 1739 workers in 2012), fabricated metal products (362 workers in 2011, and 189 in 2012), and electrical equipment production (112 persons in 2011) (Jakubowski, 2014).

Diseases of respiratory system represent one of the most frequent causes of workplace disability among employees of

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Table 1 – Clinical and occupational characteristics in the study group.

	X	Me	SD	Min	Max
Age (years)	44.08	46.00	9.80	24.00	59.00
Height (m)	1.77	1.78	0.07	1.60	1.96
Body mass (kg)	83.34	82.00	9.92	62.00	105.50
BMI (kg/m^2)	26.64	26.11	3.90	19.66	34.10
SBP (mmHg)	116.92	115.00	15.14	95.00	135.00
DBP (mmHg)	77.79	80.00	10.38	55.00	85.00
TC (mg/dl)	184.06	171.00	71.13	106.00	214.00
LDL (mg/dl)	100.51	97.00	34.95	38.00	137.00
HDL (mg/dl)	56.62	55.00	16.44	47.00	95.00
TG (mg/dl)	207.45	150.00	183.78	45.00	456.00
GLC (mg/dl)	93.24	92.00	15.47	85.00	105.00
Pb-B (μg/l)	207.11	156.00	162.73	27.20	654.00
ZnPP (μg/dl)	46.39	29.00	36.89	17.00	153.00
Duration of work with exposure to lead (years)	13.91	15.00	5.05	1.00	21.00
		N		%	
Overweight/obesity		28		40.58	
Smoking habit		22		31.88	

BMI, body mass index; DBP, diastolic blood pressure; GLC, glucose concentration; Max, maximal value; Me, median value; Min, minimal value; Pb-B, blood lead concentration; SBP, systolic blood pressure; SD, standard deviation; TC, total cholesterol concentration; TG, triglycerides concentration; X, arithmetic mean; ZnPP, blood zinc protoporphyrin concentration.

industrial institutions. Analysis of sickness absences among persons covered by social insurance system in Poland demonstrated that in 2009 respiratory tract diseases were the second most frequent cause of absenteeism, accounting for 15.9% of the total number of absence days (Wojtyniak, 2012).

Spirometry is a test of a great value that helps to diagnose various lung diseases. It is said that spirometry is the most commonly performed lung function test measuring such parameters as vital capacity and forced expiratory volume. The most important parameters of the test in clinical aspect are: forced vital capacity (FVC), forced expiratory volume (in 1 s) (FEV1) and Tiffeneau index (FEV1%VC). The decrease in FEV1%VC ratio below lower limit of normal indicates obstructive lung disease, and the decrease in FVC below lower limit of normal – a restrictive disorder, if there is no obturation present; however, decrease in FEV below limit of normal, with simultaneous decrease in FEV1%VC ratio – a mixed ventilatory defect or a hyperinflation. FEV 1 enables to determine the degree of obstruction, that is, mild, moderate or severe. Peak expiratory flow (PEF) is used to monitor patients, mainly those suffering from asthma. The other parameters such as maximum midexpiratory flow (MMEF), maximal expiratory flow for 25% FVC (MEF25), maximal expiratory flow for 50% FVC (MEF50) and maximal expiratory flow for 75% FVC (MEF75) are rather additional parameters (Johns et al., 2014).

Although, respiratory tract is a main lead entry route, still there are not too many data on its disadvantageous effects on the ventilation parameters. The up-to-date reports about the function of respiratory system in people occupationally exposed to lead are still not unequivocal (Bagci et al., 2004; Onarlioglu et al., 1998, 1999; Adamson et al., 1999). Authors of the present study think that it was necessary to confirm or verify if there was a relationship between expose to lead and the function of respiratory system.

This study aimed at evaluation of selected spirometric parameters in persons occupationally exposed to lead without evident health problems.

2. Methods

A group of 86 consecutive men were included into the study, who filled the criteria for occupational exposure to lead. They were recruited from the ironworks workers from two centers in Głogów and Legnica (Poland) by the physician during prophylactic medical examination at their workplace and then they were sent for medical tests to Department of Internal Medicine, Occupational Diseases and Hypertension in Wroclaw Medical University. The further prophylactic tests were carried out by the physicians from the department and they included general typical internal medicine tests, and more specific medical consultations from lung diseases, cardiology, gastroenterology and neurology. The following points were accepted as the inclusion criteria: employment at the worksite with documented exposure to lead, the total time of work at the worksites with documented exposure to lead at least 5 years, and no current exposure to other chemical or physical factors. The men inhabited the same area and in this respect they experienced the same size and quality of environmental exposure. At the next stage, the men were excluded from the group who admitted in anamnesis that they suffered from arterial hypertension, ischemic heart disease, heart failure, atherosclerosis, hypercholesterolemia, hypertriglyceridemia, diabetes mellitus, renal insufficiency, hyper- or hypothyroidism. As a result, the group of 69 men was obtained, occupationally exposed to lead without evident health problems. General characteristics of the examined group are presented in Table 1.

At the subsequent stage of the study subgroups of participants were selected, basing on cut-off points of median values for blood lead concentration and blood zinc protoporphyrin concentration (Pb-B and ZnPP) and maximum admissible concentrations (MAC) of blood lead concentration and blood zinc protoporphyrin concentration. The criteria of subgroup selection are presented in Table 2.