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Respiratory and cardiovascular functions among smoking and nonsmoking girls from two regions with different air pollution degree

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Abstract

Aim: The aim of the present study was to analyze the respiratory and cardiovascular functions among smoking and nonsmoking girls attending two schools situated in regions with different levels of air pollution. The characteristic of air pollution is based on the data gathered by stations 1 and 2 belonging to the Uniform National System for Monitoring the Air Pollution in Bulgaria. The participants ($n = 108$, 16.07 ± 0.80 years) were separated in two groups: smokers ($S1$ – from school 1, $S2$ – from school 2) and nonsmokers (NS1 – from school 1, NS2 – from school 2). All of them performed pulmonary function testing and .cardiopulmonary exercise testing on a treadmill using our modification of the Balke protocol (Marinov et al., 2000). Reference values for European children, previously validated for the Bulgarian population, were used.

Results: There are no significant differences in mean levels of VC, IC, FEV_1, MEF_{50} and MEF_{25} (as a percentage from the predicted value as well). The average level of the Tiffneau index is noticeably higher among nonsmokers from the two regions and is the lowest among smokers from the more polluted area, but a signigicant difference exists between $S2$ (88.7 ± 5.9) and NS2 (92.6 ± 4.7), $p = 0.047$; $T_{L,CO}$%pred: $S1$ (85.4 ± 7.2) vs. $S2$ (86.7 ± 8.2), $p = 0.048$ and NS1 (88.3 ± 8.2) vs. NS2 (92.8 ± 14.5), $p = 0.037$; V_E%pred: $S1$ (127.5 ± 9.6) vs. $S2$ (123.7 ± 6.1), $p = 0.035$; higher levels of total lung capacity (TLC%pred), $S1$ (107.3 ± 9.2) vs. NS2 (104.3 ± 9.1), $p = 0.009$ and alveolar ventilation (VA), $S1$ (5.0 ± 0.6) vs. NS2 (4.6 ± 0.5), $p = 0.008$.

Conclusions: 1. The negative effects of the combined influence of tobacco smoking and air pollution on some respiratory and cardiovascular functions of adolescent girls are more pronounced than each influence alone. 2. The cardiopulmonary exercise test gives adequate information about the combined effect of air pollution and smoking and using it for preventive purposes is an advisable method.

Keywords: Air pollution; Cardiovascular functions; Nonsmokers; Respiratory function; Smokers

Introduction

Smoking is a hazard to human health. It is connected etiologically with respiratory function decline (Jaakkola, 1994; Rizzi et al., 2004; Weiss et al., 1980), especially in

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young people. The rate of smoking in Bulgaria increased significantly in the past few years, especially among women, children and teenagers. The lower bound to start smoking is under the age of 13. Health damages in children and adolescents as a result of cigarette smoke are not the only harm of early smoking. The age at which smoking begins determines to a great extent its addiction strength, i.e. early beginning predestines a longer continuance and higher intensity of the unhealthy habit. It is also known that smoking by children and adolescents is related to impaired lung growth. In general, smokers' lung function declines faster than that of nonsmokers and the most important – smoking by children and adolescents accelerates the onset of lung function decline during late adolescence and early adulthood.

Smoking is extremely dangerous for women and their reproductive function and can harm every phase of the reproduction. Even more striking – about 8% of all neonates with low birth weight born in the Czech Republic may be attributed to environmental tobacco smoke exposure of nonsmoking mothers (Dejmek et al., 2002). That is why for the purpose of well-grounded knowledge of health prevention it is very important to investigate the changes of health indicators among the future mothers, namely among adolescent girls. This is necessary because of the earlier development of lungs and the characteristics of the proportion air ways/lungs' parenchyma in girls – conditions for earlier progress of diseases with obstructive syndrome (Becklake and Kauffmann, 1999; Neve et al., 2002).

Another hazardous health factor is air pollution. Along with tobacco smoking it can be the reason for many health injuries (WHO, 2004a), including functional respiratory disorders (Dockery and Brunekreef, 1996). Although the influence of each factor is thoroughly investigated and analyzed, there are only few and contradictory investigations on their combined effect. It is reported that dust (389 and 449 μg) and sulfur dioxide (128 and 57 μg) pollution leads to a reduction of the forced expiratory volume in 1 s (FEV_1) and the forced vital capacity (FVC) by adult smokers and nonsmokers, and the reduction in smokers is considerably and significantly greater than in nonsmokers (Xu and Wang, 1998). According to Pope and Kanner (1993) the respirable dust (PM10) has a weak, transitory, negative effect on permanent smokers, which cannot be fully obscured by smoking. There are also investigations available, which do not show differences in the respiratory functions in smokers and nonsmokers regardless of the differences in the degree of air pollution. For example, Ortega et al. (1990) have reported that there is no reduction of FVC, FEV_1, $FEF_{25\%}$, $FEF_{50\%}$, neither in smokers, nor in nonsmokers among 1416 pupils of both sexes (7–14 years of age), active and passive smokers who live in the same town but in 2 regions with different levels of air pollution. Those varying results have urged us to apply very precise methods for investigating the combined action of smoking and air pollution on health. What we needed simultaneously with spirometry was a method, which gives us an idea about the changes in the functional reserves of the organism. The latter is best characterized by subjecting the person to physical exercise. On the top of the diagnostic pyramid are tests with monitoring of gas exchange. Cardiopulmonary exercise tests make it possible for the investigator to assess not only the standard parameters and indices of the respiratory and cardiovascular systems but the combined effect of their interaction.

The aim of the present study is to analyze the respiratory and cardiovascular functions among smoking and nonsmoking girls attending two schools, situated in regions with a different level of air pollution.

Materials and methods

This study was carried out during May and June 2003, in the town of Plovdiv (the second largest city in Bulgaria, population of 350 000) as part of a larger investigation. The characteristics of air pollution are based on the data gathered by stations 1 and 2 which belong to the Uniform National System for Monitoring the Air Pollution in Bulgaria. Station 1 is situated in region 1 and is relevant for the quality of the atmospheric air in the central part of the town – intensive motor traffic (about 600 vehicles per hour), local steam boiler installations, the central railways station and the public transport stations. Station 2 is located in region 2, situated in the over wind zone of the town near a park and far from massive sources of atmospheric pollutants; it falls under the influence of low intensity traffic and one local steam boiler installation. The samples are collected manually using the aspiration method all working days long. The gases are collected 4 times during daylight hours and the total suspended particulate matter (TSPM) over 8 h continuously. Pollution of the systematic controlled pollutants on the two stations during 2003 is analyzed: TSPM, sulfur dioxide and nitric dioxide (mean year levels). Mean pollution levels during May and June (for the same year) were analyzed separately. Because of the manual sampling CO, O_3 and other pollutants are not analyzed.

One hundred and twenty-eight volunteering, clinically healthy girls at age 15–17 attending schools 1 and 2 (situated in regions 1 and 2) have taken part in the study. The participants from both schools were separated in two groups: smokers (*S*1 – from school 1, *S*2 – from school 2) and nonsmokers (NS1 – from school 1, NS2 – from school 2). Since age has a crucial role for the