The impact of tobacco smoking on the selected cardiovascular risk factors in young men

Wpływ palenia tytoniu na wybrane czynniki ryzyka sercowo-naczyniowego u młodych mężczyzn

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Summary
The aim of the study was to assess the influence of tobacco smoking on some traditional cardiovascular (CVD) risk factors in young men.

Material and methods. We analyzed the results of cardiovascular screening management on medical students aged 20-24. The study was conducted on 140 men, 58 non-smokers (NS) and 82 smokers (S) declared as healthy individuals. The subjects were measured body mass index (BMI), systolic (SBP) and diastolic (DBP) blood pressure. They were assessed fasting parameters on capillary blood, including glucose (GLU), total cholesterol (T-C), triacylglycerols (TAG), HDL cholesterol (HDL-C), LDL cholesterol (LDL-C), using analyzer Reflotron Plus (Roche Diagnostics, USA). The results collected in groups of non-smokers (NS) and smokers (S) were calculated using Statistica 10.0 version.

Results. NS and S did not differ with their age, BMI, DBP and SBP, and GLU. Smokers presented increased TAG, LDL-C and decreased HDL-C comparing to non-smokers.

Conclusion. Tobacco smoking, known as an independent risk factor for cardiovascular disease, can modify plasma lipid profile in young men, increasing the risk of CVD.

Streszczenie
Celem pracy była ocena wpływu palenia tytoniu na tradycyjne czynniki ryzyka chorób sercowo-naczyniowych (ChSN) u młodych mężczyzn.

Materiał i metody. Przeanalizowano wyniki badań przesiewowych studentów medycyny w wieku 20-24 lat. Badanie zostało przeprowadzone w grupie 140 mężczyzn, 82 niepalących (NS) i 58 palących (S) deklarujących dobry stan zdrowia. Badanym oceniono wskaźnik masy ciała (BMI) oraz ciśnienie skurczowe (SBP) i rozkurczowe (DBP) krwi tętniczej. We krwi włośnickiej, rano na czczo, zmierzono stężenie: glukozy (GLU), cholesterolu całkowitego (TC), triacylogliceroli (TAG), cholesterolu HDL (HDL-C); wyliczono stężenie cholesterolu LDL (LDL-C). Stężenia parametrów mierzono na analizatorze Reflotron Plus (Roche Diagnostics, USA). Analizę statystyczną wyników w grupach osób niepalących (NS) i palących (S), przeprowadzono przy użyciu programu Statistica 10.0. Wyniki. Grupy NS i S nie różniły się pod względem wieku, BMI, wartości ciśnienia tętniczego (SBP, DBP) oraz stężeń GLU. U osób palących (S) obserwowano zwiększone stężenia TAG i LDL-C, oraz obniżone stężenia HDL-C w porównaniu z osobami niepalącymi.

Wniosek. Palenie tytoniu, uznawane za niezależny czynnik ryzyka ChSN, może modyfikować profil lipidowy u młodych mężczyzn, zwiększając ryzyko chorób układu krążenia.

Key words: mężczyźni, palenie tytoniu, profil lipidowy

Słowa kluczowe: men, tobacco smoking, lipid profile

Introduction
Cardiovascular disease (CVD) is one of the most common causes of morbidity and mortality in developed countries, and is one of those called the civilization disease. In Poland, this is responsible for 50% of deaths, of which the most common causes are myocardial infarction (MI) and stroke. Years of epidemiological observations have shown that among patients with coronary heart disease (CHD), smokers are diagnosed MI more frequently. In middle-aged men, smoking more than 20 cigarettes a day, the risk of myocardial infarction is three
times increased comparing with non-smokers [1]. The incidence of cardiovascular disease in the world is growing. Two million people die because of CVD in the European Union every year. Despite a significant reduction in mortality rates in recent decades, CHD is still responsible for 16% of deaths in men and 15% of deaths in women [2]. Factors known to increase the risk of CVD may be related to lifestyle, physiological/biochemical characteristics and individual features. The categories include wide range of variables: age, gender, family history, obesity, central distribution of body fat, smoking, physical inactivity, improper diet, hypertension, dyslipidemias, hyperglycemia, and prothrombotic factors [2, 4].

According to a study conducted in the U.S., half of all adults have at least one risk factor for CVD. Less than 1% of the population presents an ideal state of health (no risk factors). Approximately 65% of patients do not control their classic risk factors. Mortality from CHD may increase due to the increasing prevalence of obesity in this population [3].

The prevalence of coronary heart disease in young adults is lower than in elderly. It was calculated 3% of all cases of coronary heart disease and 2-6% of all myocardial infarctions in the population aged under 45 [4]. Therefore, early detection and treatment of subclinical form of the disease is important in young, asymptomatic patients who seldom undergo medical evaluations to estimate the risk [2, 4].

In 2010 American Heart Association (AHA) has proposed the concept of ideal cardiovascular health, which is defined as simultaneous presence of 4 ideal health behaviors and 3 ideal health factors, explained in detail in the document. The health behaviors of particular importance are: abstinence from nicotine, normal body mass index (BMI<25.0 kg/m²), central distribution of body fat, smoking, physical inactivity, proper nutrition, increased physical activity, and stress, can and should be corrected by appropriate measures and counseling. Preventive management - necessary, cheapest and most effective form - is realized through lifestyle modifications.

The basic laboratory tests are useful to identify biochemical factors contributing to the development of CVD, but also to monitor the effectiveness of the prevention, including plasma lipid profile (total cholesterol, triacylglycerols, HDL cholesterol and LDL cholesterol), and glucose concentrations [5].

A lot of studies document the prognostic significance of these parameters for the occurrence of coronary incidence, especially in middle- and old-age population. The researchers discuss the interrelationship of risk factors and their determinants. The atherosclerotic process begins early in life and the highest intensity occurs between 14-35 years, hence the World Health Organization (WHO) recommends to start the screening in a group of healthy young adults already at 20 years of age [6].

It is a moment in which young healthy people entering working life, but also good time for the most effective lifestyle modification.

The aim of the study was to evaluate selected parameters of lipid and glucose metabolism, and blood pressure in healthy young male volunteers with regard to smoking habit.

Material and methods

The study was performed in accordance with the Declaration of Helsinki for Human Research and the study protocol was accepted by the Bioethical Committee of University of Medical Sciences in Poznan, Poland. The study presents an analysis of the results of screening procedure in a group of healthy volunteers - students from the University of Medical Sciences. 140 male Caucasians, aged 20-24, without any acute or chronic disease, using neither special diet nor medication, participated in the study. A group of smoking man (S) consisted of 58 people aged 22±3 years and a group of non-smokers (NS) consisted of 82 men aged 22±2 years. Students who smoked between 5 and 20 cigarettes per day were enrolled into a group of smokers.

Subjects underwent complete physical examination, including the measurements of weight and height for the calculation of body mass index (BMI, kg/m²), and the assessment of systolic (SBP) and diastolic (DBP) arterial blood pressure. The arterial blood pressure was measured on a left arm, twice, using an appropriate size cuff and sphygmomanometer MEDEL Palm Pro 91431 (Medel, Italy). The SBP and DBP were assessed after at least 15 minutes’ rest in a sitting position, and the result was expressed as the mean value of two measurements.

Finger capillary blood was drawn after overnight fast, lasting 12-14 hours, to three 32 μl-heparinized-capillars for the measurement of glucose (GLU), total cholesterol (T-C) and triacylglycerols (TAG) concentrations, and one 100 μl-EDTA-microvette to obtain EDTA plasma for the measurement of HDL cholesterol (HDL-C) concentration. The capillary blood was used immediately on Reflotron Plus biochemical analyzer (Roche Diagnostics, USA) with a procedure of erythrocyte separation from plasma on the strip, as well as EDTA plasma obtained. The lipid profile, including the concentrations T-C, HDL-C and TAG along with GLU, were directly measured. The enzymatic methods were used for the measurement of GLU (glucose oxidase, peroxidase) in the range of 10 to 600 mg/dL, T-C (cholesterol esterase, cholesterol oxidase, pe-
roxidase) in the range of 100 to 500 mg/dL, TAG (esterase, glycerol kinase, glycerol-3-phosphate oxidase, peroxidase) in the range of 70 to 600 mg/dL, and HDL-C (dextran sulfate/Mg²⁺, cholesterol esterase, cholesterol oxidase, peroxidase) in the range of 10 to 100 mg/dL.

LDL cholesterol (LDL-C) was calculated according to Friedewald formula \( \text{LDL-C} \ [\text{mmol/L}] = (\text{T-C} - \text{HDL-C} - \text{TAG/2.2}) \).

The venous blood plasma of healthy volunteers was used to assess the intra- and inter-assay coefficient of variation, like 1.5% and 2.0% for GLU, 2.4% and 2.8% for T-C, 2.3% and 3.3% for HDL-C, and 2.2% and 3.1% for TAG.

The reference sera level 1 and level 2 (Randox Laboratories, Crumlin, Antrim, UK) and Reflotron Check strip system were used for monitoring the accuracy of the above determinations.

Statistical analysis was performed using Statistica 10.0 for Windows program. The distributions of clinical and biochemical parameters were verified by Shapiro-Wilk’s test. Differences between the groups were assessed by non-parametric Mann-Whitney U test.

### Results

The characteristics of the study groups, smokers (S) and non-smokers (NS), are shown in Table I and Table II, respectively. There were no statistical differences between S and NS groups regarding their age, BMI, GLU and DBP or SBP values, what was a consequence of settings of the study to qualify healthy young males for investigation.

The significant differences between S group and NS group were found for TAG, HDL-C, LDL –C (Table III).

### Discussion

Despite establishing a category of independent, traditional CVD risk factors for human population, their mutual relationships and ways of effective prevention of myocardial infarction and stroke are still discussed.

AHA concept of ideal cardiovascular health explained by the presence of health behaviors (non-smokers, normal BMI, the recommended physical activity, recommended diet) together with clinical and laboratory factors (normal T-C, correct SBP and DBP, normal blood glucose level) [5] needs to be followed.

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**Table I.** The characteristics of smoking males (n=58). Data are presented as values of minimum, (min) maximum (max), median, mean, standard deviation (SD) and percentage of males presenting out of reference-results (% of ↑ / ↓ results), as follows T-C>4.9 mmol/L, TAG>1.7 mmol/L, HDL-C<1.0 mmol/L and LDL-C<3.0 mmol/L.

<table>
<thead>
<tr>
<th>Smoking men</th>
<th>min</th>
<th>max</th>
<th>median</th>
<th>mean</th>
<th>SD</th>
<th>% of ↑ / ↓ results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>20</td>
<td>24</td>
<td>22</td>
<td>22</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>18.0</td>
<td>24.0</td>
<td>21.0</td>
<td>21.2</td>
<td>2.1</td>
<td>-</td>
</tr>
<tr>
<td>GLU mmol/L (mg/dL)</td>
<td>(61.0)</td>
<td>(95.0)</td>
<td>(70)</td>
<td>(69.7)</td>
<td>(0.33)</td>
<td>-</td>
</tr>
<tr>
<td>T-C mmol/L (mg/dL)</td>
<td>(100.0)</td>
<td>(222.0)</td>
<td>(155.0)</td>
<td>(150.4)</td>
<td>(26.6)</td>
<td>6.9</td>
</tr>
<tr>
<td>TAG mmol/L (mg/dL)</td>
<td>(70.0)</td>
<td>(200.0)</td>
<td>(100.0)</td>
<td>(89.2)</td>
<td>(33.5)</td>
<td>1.7</td>
</tr>
<tr>
<td>HDL-C mmol/L (mg/dL)</td>
<td>(35.0)</td>
<td>(100.0)</td>
<td>(57.7)</td>
<td>(59.4)</td>
<td>(14.9)</td>
<td>3.5</td>
</tr>
<tr>
<td>LDL-C mmol/L (mg/dL)</td>
<td>(42.0)</td>
<td>(140.0)</td>
<td>(75.2)</td>
<td>(76.8)</td>
<td>(26.6)</td>
<td>8.6</td>
</tr>
</tbody>
</table>

**Table II.** The characteristics of non-smoking males (n=82). Data are presented as values of minimum, (min) maximum (max), median, mean and standard deviation (SD).

<table>
<thead>
<tr>
<th>Non-Smoking men</th>
<th>min</th>
<th>max</th>
<th>median</th>
<th>mean</th>
<th>SD</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>20</td>
<td>24</td>
<td>22</td>
<td>22</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>18.0</td>
<td>24.0</td>
<td>21.0</td>
<td>21.0</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>GLU mmol/L (mg/dL)</td>
<td>3.45 (62.0)</td>
<td>5.28 (95.0)</td>
<td>3.89 (70.0)</td>
<td>4.00 (71.9)</td>
<td>0.39 (7.0)</td>
<td></td>
</tr>
<tr>
<td>T-C mmol/L (mg/dL)</td>
<td>2.59 (100.0)</td>
<td>5.17 (200.0)</td>
<td>4.00 (155.0)</td>
<td>3.94 (152.4)</td>
<td>0.63 (24.5)</td>
<td></td>
</tr>
<tr>
<td>HDL-C mmol/L (mg/dL)</td>
<td>1.16 (45.0)</td>
<td>2.59 (100.0)</td>
<td>1.87 (72.5)</td>
<td>1.94 (74.9)</td>
<td>0.28 (10.9)</td>
<td></td>
</tr>
<tr>
<td>LDL-C mmol/L (mg/dL)</td>
<td>0.90 (35.0)</td>
<td>3.10 (120.0)</td>
<td>1.62 (62.5)</td>
<td>1.62 (62.7)</td>
<td>0.57 (21.9)</td>
<td></td>
</tr>
</tbody>
</table>

**Abbreviations:** BMI – body mass index; GLU – plasma glucose; T-C – plasma total cholesterol; TAG – plasma triacylglycerols; HDL-C – plasma high-density lipoprotein cholesterol; LDL-C - plasma low-dense lipoprotein cholesterol; SD – standard deviation.
Table III. The comparison between smoking (S) and non-smoking (NS) man, with statistically significant difference marked (*), while p<0.05. Data are shown as mean ± standard deviation.

<table>
<thead>
<tr>
<th></th>
<th>Smoking men</th>
<th>Non-smoking men</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>22±3</td>
<td>22±2</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>21.2±2.1</td>
<td>21.0±2.5</td>
</tr>
<tr>
<td>GLU mmol/L (mg/dL)</td>
<td>3.87±5.9 (69.7±5.9)</td>
<td>4.00±0.39 (71.9±7.0)</td>
</tr>
<tr>
<td>T-C mmol/L (mg/dL)</td>
<td>3.89±0.69 (150.4±26.6)</td>
<td>3.94±0.63 (152.4±24.5)</td>
</tr>
<tr>
<td>TAG mmol/L (mg/dL)</td>
<td>1.02±0.38 (89.2±33.5) *</td>
<td>0.87±0.27 (76.8±23.9) *</td>
</tr>
<tr>
<td>HDL-C mmol/L (mg/dL)</td>
<td>1.54±0.39 (59.4±14.9) *</td>
<td>1.94±0.28 (74.9±10.9) *</td>
</tr>
<tr>
<td>LDL-C mmol/L (mg/dL)</td>
<td>1.99±0.69 (76.8±26.6) *</td>
<td>1.62±0.57 (62.7±21.9) *</td>
</tr>
</tbody>
</table>

Abbreviations: BMI – body mass index; GLU – plasma glucose; T-C – plasma total cholesterol; TAG – plasma triacylglycerols; HDL-C – plasma high-density lipoprotein cholesterol; LDL-C - plasma low-density lipoprotein cholesterol; SD – standard deviation.

The first study discussing the ideal cardiovascular health metrics, addressing cardiovascular status in middle-aged subjects, following assessed risk factors in youth, was published in 2012. In the cited work perfect indicator of cardiovascular health was associated primarily with normal SBP and DBP, T-C and glucose levels in youth. Situation was not changed by smoking in young people, but the association of cigarette smoking and elevated TAG was observed, although not statistically significant [7].

The results of our study show increased levels of TAG and LDL-C, but also reduced HDL-C in the S group. Some studies have also reported slight differences in the increase in total cholesterol and LDL cholesterol, and decrease in HDL cholesterol in groups of smokers compared with non-smokers. Smoking cessation (irrespective of the number of cigarettes smoked) is associated with improved lipid profile (in particular the increase in HDL -C), which is associated with decreased risk of cardiovascular disease. In the United States population studies, the increase in HDL-C was associated with a 2-3% reduction in the occurrence of cardiovascular events. Smoking cessation was associated with a small but noticeable decrease in TAG concentration. There were no changes in LDL cholesterol [8, 9].

In the Japanese population studies, cigarette smoking increased TAG concentration of 0.15 mmol/L (13 mg/dL), and decreased HDL-C by 0.08 mmol/L (3.5 mg/dL) - for every 20 cigarettes smoked. The concentrations of individual fractions of cholesterol are also influenced by lifestyle factors. Physical activity as a regular moderate exercise 3 x per week x 30 minutes, cause a decrease in the concentration of TAG by 0.11-0.23 mmol/L (10-20 mg/dL) and an increase in HDL-C by 0.13-0.26 mmol/L (5-10 mg/dl). Changes in the daily diet, with a reduction in the consumption of saturated fatty acids and cholesterol, lower the concentration of T-C, TAG and increase the concentration of HDL-C [10].

The TG/HDL abnormalities have been suggested to be related to insulin resistance, a key link between smoking and CVD [11, 12]. Cigarette smoking increases oxidative modification of LDL and has also been associated with an increased level of multiple inflammatory markers including C-reactive protein, interleukin-6, and tumor necrosis factor alpha. Adhesive molecules, i.e. E-selectin levels are higher in smokers [11, 13]. Many of the abnormalities connected with smoking, including endothelial dysfunction, proinflammatory effects on the vessel wall, an immune response, prothrombotic effects (increased platelet reactivity), reduced endogenous fibrinolysis, and lipid peroxidation, can largely be explained by the effects of increased oxidative stress. Smoking was shown to be associated with development of atherosclerosis in young people [11, 12, 13, 14].

Published work suggests lower BMI among smokers compared to non-smokers [15], what was not observed in our study. However, it should be noted that smoking is one of the many factors influencing body weight. In our study we did not take into account neither the duration of smoking habit nor the number of cigarettes used a day.

There are some academic disciplines requiring greater involvement and effort (e.g. to study medicine), which could be associated with significant lifestyle changes. Students spend a lot of time and energy to learn, often at the expense of a healthy lifestyle (reduced physical activity, poorer nutrition). The published data show, that many students, regardless of field of study, eagerly reach for cigarettes. According to our observations, there is a reduction in the number of students identifying themselves as "smokers" (those, who are addicted to smoking cigarettes, who smoke more cigarettes regularly during the day and month, and who need for a cigarette within 30 minutes of awakening). Increasingly, students experiment with smoking defining themselves as "social smokers", especially during social gatherings and leisure time [16].

It is also known that the decrease in body weight in smokers is linked to the effect of nicotine by reducing appetite, altered foods taste, longer intervals between meals and a minor amount of calories consumed per day [17]. American Studies show that about 30-50% of young people experimenting with smoking, is susceptible to addiction to tobacco and smoking habit. At the same time, those students who do not define themselves as “smokers” are more likely to quit smoking [16]. The most discouraging factor for smoking
cessation is the fear of gaining weight (an average of about 4-6 kg) [17, 18]. Currently, it is estimated that at least 19% of women and 23% of men in the United States, and 26% of the population aged over 15 years in the European Union smoke cigarettes [19, 20]. Most publications evaluating the effect of cigarette smoking on lipid parameters in the general population consider middle-age people, often with some co-morbidities. According to the current guidelines for CVD prevention, recommending an assessment of risk factors at age 20, we analyzed the effect of smoking on lipid parameters in young adults. This study was performed in a group of healthy young men entering working life, at a time when the most effective lifestyle modification is still possible. According to many authors, the selection of prevention programs and urging smoking students to quit smoking before the graduation, is particularly important. Increasing the number of non-smokers, especially in medical schools, we do not only reduce the potential health risks, but also enhance their crediblity as people professionally related with the prevention and promotion of health [16, 21, 22].

Conclusion
Smoking adversely affects the lipid profile, and as an independent cardiovascular risk factor increases the possibility of future CVD in young men.

Bibliography:

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