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THE OCCURENCE OF RISK FACTORS OF CARDIOVASCULAR DISEASES AND THE EFFECT OF SELECTED DIETARY HABITS ON THE LIPID PROFILE AND BODY MASS INDEX

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ABSTRACT

In a group of 204 randomly selected patients hospitalized in the Cardiocentre Nitra, of which 63 were women (30.88%) and 141 men (69.12%), we evaluated the prevalence of modifiable risk factors for cardiovascular diseases and the impact of dietary habits on the lipid profile and body mass index (BMI). We have recorded a high prevalence of risk factors, especially overweight and obesity, where 87.3% of women and 92.91% of men had BMI ≥25. Normal weight was observed only in 12.70% of women and in 7.09% of men. In the study group up to 60.32% of women and 57.45% of men had blood pressure higher than ≥130/85 mmHg. More than half of the respondents were simultaneously overweighted or obese together with high blood pressure occurence. The total cholesterol level higher than 5.2 mmol/L was recorded in 41.24% of women and 34.75% of men. There was statistically significant difference between men and women (p <0.05) in the prevalence of low HDL cholesterol to the detriment of men while the value below 1.3 mmol/L was recorded in 31.75% of women and the value lower than 1.1 mmol/L in 52.48 % of men. Values of triglycerides (TG) ≥1.7 mmol/L were recorded in 28.57% of women and in 35.42% of men. Fasting blood glucose levels ≥5.6 mmol/L were recorded in up to 68.25% of women and 71.63% of men. There was not statistically significant difference (P >0.05) in the occurrence of increased levels of cholesterol, triglycerides, blood pressure and glycemia according to gender. We found out that most of the respondents consumed food 3-4 times per day, i.e. 53.97% of women and 60.99% of men. Food intake for five to six times a day was reported only by 28.57% of women and 19.15% of men. The number of daily meals was significantly reflected in the BMI values in men who consumed food 1-2 times a day compared to the men who ate 3-4 meals daily (p <0.001). We detected lower BMI values in women with more frequent food consumption, however the difference was not statistically significant. While assessing the nutritional history, we have recorded frequent consumption of meat and meat products which are consumed by 49.21% of women and 60.28% of men (p <0.001) more than four times a week, while more than 30% of women and men consume them daily. On the contrary, women consume fish more often, while 53.97% of women and 48.23% of men consume it 1 to 2 times a week. Although fruit and vegetable are part of daily diet of almost all patients, it is insufficient in portions of one or two pieces a day compared with dietary recommendations. We noticed significantly higher BMI (p <0.05) in men who consume sweetened beverages, than men who consume mostly non-sweetened beverages.

Keywords: cardiovascular disease; risk factor; dietary habits; lipid profile; body mass index

INTRODUCTION

Cardiovascular diseases (CVD), including coronary heart disease (CHD) and stroke, currently represent the major causes of mortality and morbidity all over the world. In Europe, CVD are responsible for 43% of deaths in men and 55% in women and for 30% of all deaths before the age of 65 years. Eighty percent of cardiovascular accidents could probably be avoided by lifestyle adjustment (weight control, smoking abstinence, physical activity, and a healthy diet), together with proper management of clinical and biological risk factors **(Carpentier and Komsa-Penkova, 2011)**.

The major typical feature of CVD is the atherosclerotic plaque, an inflammatory lesion which develops insidiously around cholesterol depots in the intima of the arterial wall over many (20-30) years **(Peters et al., 2011)**. Cholesterol deposition and development of inflammatory lesions are prevented by high-density lipoproteins (HDL) which ensure a reverse cholesterol transport to the liver (and glands producing steroid-derived hormones) and reduce inflammatory and peroxidative reactions. It is important to understand that endothelial dysfunction and inflammatory reactions may be corrected by appropriate lifestyle and therapeutic measures, causing the atherosclerotic lesion to be reversed, modified or stabilised. As a corollary, the vast majority of CVD accidents can and should be prevented **(Carpentier and Komsa-Penkova, 2011)**. For a long time plasma cholesterol concentration has been considered as the major (if not the only one) risk factor for CVD **(Ferrieres, 2004)**. The major responsible factors for CVD

are the higher levels of low density lipoprotein cholesterol (LDL) and lower levels of the high density lipoprotein cholesterol (HDL) present in blood plasma **(Fruchart and Duriez, 2002)**. Since cholesterol deposition in the arterial wall is a key and early step in the initiation of the atherosclerotic process, decreasing the number of LDL particles (and/or avoiding their retention in the intimal space) has been a primary target **(Brunzell et al., 2008)**. Attention is currently paid not only to decreasing LDL cholesterol, but also to increasing the number of HDL particles; this can be achieved by lifestyle adjustments: weight control, physical activity, no-smoking and proper nutrition. A high concentration of plasma triglycerides is recognised as a direct risk factor (increased coagulation, impaired endothelial function, but may also have indirect effects by decreasing HDL level and increasing LDL atherogenicity via formation of atherogenic small dense LDL.

The American Heart Association (AHA) recently defined a construct of "ideal cardiovascular health" comprising 7 health metrics: no smoking, engaging in sufficient physical activity, consuming a healthy diet, maintaining a normal body mass index (BMI), and having optimal levels of total cholesterol, blood pressure, and fasting blood glucose **(Lloyd-Jones et al., 2010)**. The more of these risk factors a person has, the more it runs the risk of development of CVD. The risk, of course, also increases with increasing intensity of a specific risk factor. Specific treatment for individual risk factors of atherosclerosis is different, but the principles of treatment are the most common of them. The basic treatment of most risk factors is suitable diet regime and compliance measure **(Whitney-Rolfes 2002)**.

It is widely recognized that diet plays a critical role in the development of CVD. While foods from animal sources contain important nutrients that may not be readily available from plant sources, high consumption of red meats has been shown in association with greater risk of morbidity and mortality from CVD. Such diets may contain high levels of total and saturated fats and cholesterol. In addition, accumulated evidence supports that fish or sea food consumption may have cardioprotective effects. Long-chain omega-3 polyunsaturated fatty acids including eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) which are suggested to be the key nutrients responsible for the observed benefits of fish consumption on CVD. Numerous studies have demonstrated the benefits of diets high in fruits, vegetables, whole grains, and fish, and low in red meat, high-fat dairy products, and trans and saturated fats **(Daviglus and Pirzada, 2008)**. High consumption of fruit and vegetables is likely to reduce hypertension, coronary heart disease and cancer. Furthermore a high consumption of milk and dairy products, is negatively associated with all-cause deaths, ischaemic heart disease, stroke and incidence of diabetes **(Boeing et al., 2012; Sayon-Orea et al., 2013)**. Whereas, the increased consumption of pre-prepared, fatty, and salty food is known for promotion cardiovascular risk factors and therefore should be avoided **(Perk et al., 2012)**. Healthy lifestyle, including healthy diet, is the best strategy for prevention of CVD and other diseases **(Daviglus and Pirzada, 2008; Osler, 2002)**.

MATERIAL AND METHODOLOGY

We evaluated the prevalence of modifiable risk factors for cardiovascular disease (CVD) and the relationship between dietary habits and lipid profile and BMI in a group of 204 randomly selected patients hospitalized in the Cardiocentre Nitra, of who 63 were women (30.88%) and 141 men (69.12%). Respondents were 25 – 89 years old, where the average age of women was 65.40 ±10.59 years, and the average age of men was 61.04 ±11.04 years. Most of the respondents (65.08% of women and 62.41% of men) were 56 – 75 years old. Selected respondents have either overcome the myocardial infarction or were diagnosed with angina pectoris and hospitalized after a procedure so called catheterization. The largest proportion of respondents was hospitalized due to the myocardial infarction, i.e. 50.79% of women and 56.74% of men. The data necessary for detection of the presence of modifiable risk factors for CVD and dietary habits were obtained by a questionnaire method through guided conversation. The questionnaire was anonymous, its completion was voluntary with only one response to be circled for each question. Data collection was carried out simultaneously with somatometric and biochemical examination of the respondents ensured by the Cardiocentre Nitra. The following parameters were evaluated: total cholesterol, LDL cholesterol, HDL cholesterol, triglycerides and blood glucose, because these parameters are considered to be one of the major risk factors for cardiovascular diseases. We used the diagnostic criteria of the metabolic syndrome (MS) according to ATPIII criteria for the evaluation of the risk factors, as the MS brings together components that are associated with the risk of CVD, in particular, with the risk of coronary heart disease. Given the close correlation of parameters of total and central obesity in our population, the positive criteria besides the waist perimeter are considered to be also the values of BMI ≥25 $kg.m^{-2}$. The presence of risk determinants was set as follows: BMI ≥25 $kg.m^{-2}$, triglycerides ≥1.7 mmol/L, HDL cholesterol <1.0 mmol/L in men and <1.3 mmol/L in women, blood pressure ≥130/85, fasting blood glucose ≥5.6 mmol/L. We also followed a total cholesterol level ≥5.2 mmol/L. The results were evaluated with appropriate standard mathematical-statistical methods and were listed in the tables. We used the program STATISTICA Cz version 10 belonging to the available statistical programs and MS Excel 2007 and the following tests: Tukey test and $\chi 2$ test.

RESULTS AND DISCUSSION

Table 1 shows the average values of biochemical markers and BMI. The average values were higher in men than in women with the exception of triglycerides and BMI.

There are more than 300 known risk factors associated with coronary heart disease and the risk of stroke. Risk factors for CVD are important in all population groups, while one third of all CVD is connected with five risk factors in developed countries.

Table 1 Average values of selected biochemical markers and BMI.

parameter	women	men
Glucose (mmol/L)		
average ±SD	7.51 ±3.13	7.44 ±3.10
min	4.36	4.26
max	19.88	24.12
Total cholesterol (mmol/L)		
average ±SD	5.19 ±1.48	4.78 ±1.39
min	2.05	1.99
max	8.97	9.21
HDL cholesterol (mmol/L)		
average ±SD	1.47 ±0.42	1.12 ±0.40
min	0.57	0.54
max	2.6	4.12
LDL cholesterol (mmol/L)		
average ±SD	2.96 ±1.10	2.96 ±1.08
min	0.93	1.03
max	5.49	7.19
Triglycerides (mmol/L)		
average ±SD	1.34 ±0.61	1.62 ±1.06
min	0.35	0.45
max	2.79	7.39
BMI ($kg.m^{-2}$)		
average ±SD	28.48 ±3.32	30.13 ±4.57
min	20.96	21.95
max	34.13	50.50

According to the numerous studies, it was determined that the most important risk factors contributing to the higher frequency of coronary heart disease could be elevated cholesterol level, hypertension, smoking, alcohol and stress **(Kamenský, 2007)**.

Table 2 presents the prevalence of selected risk factors of cardiovascular disease in the study group.

The most frequent risk determinants among the respondents were overweight and obesity, when BMI ≥25 was recorded in 87.30% of women and 92.91% of men. Normal weight was observed in only 12.70% of women and 7.09% of men. High BMI values are associated with the development of cardiovascular risk factors such as hypertension, dyslipidemia, insulin resistance and diabetes mellitus which resulting in cardiovascular diseases such as coronary heart disease and ischemic stroke **(Wilkins et al., 2010; Wormser et al., 2011).** The development of these co-morbidities in proportion to BMI and obesity is considered as an independent risk factor for cardiovascular diseases **(Poirier et al., 2006).** Several studies demonstrated that high BMI was demonstrably associated in men and women with the manifestation of

Table 2 The occurrence of selected risk factors of cardiovascular diseases (%).

Risk factor	women	men	*p*
BMI ≥25 $kg.m^{-2}$	87.30	92.91	0.1909
Blood pressure ≥130/85 mmHg	60.32	57.45	0.7008
Cholesterol ≥5.2 mmol/L	41.24	34.75	0.3723
HDL cholesterol F <1,3 mmol/L, M <1.0 mmol/L	31.75	52.48	0.0060
Triglycerides ≥1,7 mmol/L	28.57	35.42	0.3348
Fasting blood glucose ≥5.6 mmol/L	68.25	71.63	0.7005

cardiovascular diseases such as angina pectoris, myocardial infarction, heart failure and sudden death **(Bastien et al., 2014)**. People with BMI of 25 to 28.9 have two times higher relative risk of cardiovascular diseases than people with BMI <21, while those with BMI >29 have a three-fold risk **(Peeters et al., 2003)**. Hypertension is a clinical consequence of obesity, with all its well-known consequences (especially left ventricular hypertrophy, development of heart failure and coronary heart disease) **(Huang, 1998)**, which was also confirmed by our results. Up to 60.32% of women and 57.45% of men in the study group had blood pressure higher than ≥130/85 mmHg. Blood pressure of 120/80 mmHg was recorded in 25.40% of women and 28.37% of men. More than half of the respondents was simultaneously overweighted or obese with high blood pressure (53.19% of women and 53.97% of men). The relationship between obesity and hypertension is clear: BMI increase of 3 $kg.m^{-2}$ increases systolic blood pressure for 2 mmHg. The incidence of hypertension is four times higher in individuals with overweight, and in obese ones even six to eight times higher than in individuals with normal weight **(Dixon and Brian, 2002)**. Several studies have confirmed that the reduction of the weight in an average of 3.8 kg lowered systolic blood pressure by 2.9 mmHg and diastolic blood pressure by 2.3 mmHg in 18 months **(Jones et al., 1999)**.

The cholesterol level higher than 5.2 mmol/L was recorded in 41.24% of women and 34.75% of men. There was statistically significant difference in the prevalence of low HDL cholesterol between men and women ($P < 0.05$) to the detriment of men, with a value lower than 1.3 mmol/L recorded in 31.75% of women and the value lower than 1.1 mmol/L recorded in 52.48% of men. The triglycerides ≥1.7 mmol/L were recorded in 28.57% of women and 35.42% of men and fasting blood sugar levels ≥5.6 mmol/L were recorded in 68.25% of women and 71.63% of men. There was no statistically significant difference ($p > 0.05$) in the occurence of elevated levels of cholesterol, triglycerides, blood pressure and blood glucose between both genders.

The combination of several factors, high cholesterol, hypertension and smoking markedly enhances the risk of cardiovascular accidents **(Carpentier and Komsa-Penkova, 2011)**. Simultaneous occurrence of two of risk factors such as BMI ≥25 with impaired fasting glucose levels ≥5.6 mmol/L was present in 47.62% of women and 68.08% of men. Up to 36.68% of women and 39.72% of men had three risk factors present (BMI ≥25, fasting blood glucose ≥5.6 mmol/L, blood pressure ≥130/85 mmHg). Almost 20% of the respondents (19.05% of women and 17.02% of men) had even four risk factors present (BMI ≥25, fasting blood glucose ≥5.6 mmol/L, blood pressure ≥130/85 mmHg, cholesterol ≥5.2 mmol/L).

Eating habits and their impact on lipid profile and BMI

During the twentieth century, modern technologies had increased food production (through industrialization of agriculture and food processing) and shelf life (through preservation and transport) in developed countries. These changes led to the oversupply of food, as well as to the decline in food prices, which consequently led to a change in the traditional healthy eating habits **(Golzarand et al., 2012)**. The resulting increase in consumption of meat, dairy products, and industrially prepared meals caused a high-energy nutrition rich in protein, sugar and fat, which enhances the occurrence of cardiovascular diseases, as well as the diet-dependent risk factors such as obesity, hypercholesterolemia and diabetes **(Popkin, 2014)**.

Distribution of all-day energy intake into at least five meals is an appropriate measure in the prevention of lipid metabolism disorders and obesity, since it has been recorded that people with low quantity of food doses per day had increased levels of total blood cholesterol, higher prevalence of obesity and CVD **(Jurkovičová et al., 2010)**, which was also confirmed by our results. We have recorded higher mean total cholesterol levels in men and women who consumed less daily meals, however the difference was not statistically significant. We found out that most respondents consumed food 3-4 times a day, i.e. 53.97% of women and 60.99% of men. Five to six daily food intakes were reported only by 28.57% of women and 19.15% of men. We detected statistically insignificant differences in the influence of the number of daily meals on HDL cholesterol, which was higher in women as well as men who consumed 3 – 4 meals compared to 1 – 2 daily meals. The number of daily meals is significantly reflected in the values of BMI in men who consumed 1 – 2 times a day (BMI = 33.36 $kg.m^{-2}$) compared with men who ate 5-6 meals daily (BMI = 30.19 $kg.m^{-2}$) ($p < 0.05$), we have recorded lower BMI values in women with more frequent food consumption, but the difference was not statistically significant. Neither **Keller et al. (2014)** have recorded the impact of dietary habits on BMI. Table 3 shows the consumption of selected food types and Table 4 shows the effect of the frequency of consumption of selected foods on lipid profile and BMI.

With the exemption of the impact of vegetables consumption on LDL cholesterol level in women, the different frequency of consumption of monitored food did not show to be statistically significant for the levels of lipid profile and BMI both in women and men. Consumption of meat more than four times per week was recorded in 49.21% of women and 60.28% of men, while more than 30% of women and men eat meat daily. Respondents indicated poultry and pork as the most commonly consumed meat. Both men and women had insignificantly higher values of HDL for the less frequent consumption, while the values of triglycerides and LDL cholesterol were higher for more frequent consumption. BMI values in men were insignificantly higher for daily consumption and higher for women with less frequent consumption. The interesting fact is that women consume meat products more often than men, about 66.67% of women and only 55.32% of men consume them several times per week ($p < 0.001$). In our group of respondents the consumption of fish for 1-2 times a week was recorded in only 53.97% of women and 48.23% of men. Alarming finding is that up to 34.92% of women and 48.23% of men consume it only one to two times per month. Different frequency of fish consumption in men nor women did not show to be statistically significant for the lipid profile, neither for the BMI values.

Table 3 Consumption of selected food types (%).

	women	men	*p*
Meat[1]	49.21	60.28	0.0000
Meat products[2]	66.67	55.32	0.0005
Fish[3]	53.97	48.23	0.0006
Milk and dairy products[4]	46.03	51.77	0.0908
Fruit[4]	61.90	70.21	0.0010
Vegetable[4]	57.14	62.59	0.0057
Sweets[4]	28.81	35.25	0.0046

[1]- consumption more than four times a week, [2] – consumption several times a week, [3]-consumption one to two times a week , [4]– daily consumption

Our research showed, that almost half of women (46.03%) and 36.14% of men consume semi-skimmed milk and, surprisingly, up to 32% of men do not consume it at all. The daily consumption of milk and milk products was recorded in 46.03% of women and 51.77% of men (p >0.05). Milk type neither different frequency of its consumption did not affect the lipid parameters nor the BMI values. The levels of total and LDL cholesterol were higher at the daily consumption of milk and dairy products, while the TG and BMI values were higher for the less frequent consumption.

Fruit and vegetables consumption is associated with a reduction in the incidence and mortality of various chronic diseases: cardiovascular diseases, stroke, hypertension, diabetes, obesity, and certain types of cancer **(Bazzano, 2006)**. An interesting finding is that more men than women consume fruit and vegetables daily (p <0.05), which is inconsistent with the results of **Pérez (2002)**, who states higher consumption among women. Regarding the amount of fruit consumed per day, the amount was comparable between the sexes. More than a half of the respondents consumes 1 – 2 pieces of fruit per day (55.56% of women and 57.45% of men). Similarly, the consumption of 3 – 4 pieces a day was about the same in men and women (15.87% of women and 19.14% of men).

Several studies **(Serdula et al., 1996; Subar et al., 1990; Bazzano, 2002)** state more frequent consumption of fruit and vegetables in people with normal weight compared to the obese ones. Women who eat fruit daily had statistically

Table 4 Effect of the frequency of consumption of selected foods on lipid profile and BMI.

Frequency of consumption	Total cholesterol mmol/L		LDL cholesterol mmol/L		HDL mmol/L		TG mmol/L		BMI kg/m^2	
	women	men	women	men	women	men	women	men	women	men
Meat and meat products										
daily	5.35	4.92	3.07	3.10	1.28	1.06	1.47	1.98	27.03	30.26
3x/week	5.16	4.78	3.04	3.08	1.53	1.09	1.27	1.51	29.17	30.59
Fish										
1-2x/week	5.03	4.80	3.09	3.04	1.46	1.15	1.38	1.62	28.90	29.54
1-2x/month	5.09	4.85	3.05	3.14	1.47	1.09	1.26	1.63	28.04	31.02
Milk and dairy products										
daily	5.27	4.91	3.07	2.89	1.45	1.09	1.41	1.61	28.12	29.70
not daily	5.11	4.67	2.89	2.91	1.50	1.08	1.42	1.66	28.92	30.77
Fruit										
daily	5.11	4.80	2.89	2.88	1.46	1.09	1.46	1.51	28.32	30.32
not daily	5.31	4.74	3.17	2.98	1.49	1.10	1.32	1.90	28.93	29.69
Vegetable										
daily	4.87	4.78	2.64	2.86	1.42	1.07	1.47	1.51	28.17	30.50
not daily	5.57	4.85	3.47	3.04	1.53	1.12	1.31	1.85	29.02	29.56
Sweets										
daily	5.46	5.07	3.27	3.05	1.45	1.11	1.16	1.76	27.14	30.07
not daily	5.12	4.67	2.93	2.86	1.46	1.08	1.53	1.57	29.04	30.20

insignificantly lower BMI values compared with women who consumed it less often. The difference between men and women was also recorded in the consumption of vegetables, which is consumed in the amount of 1 – 2 pieces a day by 44.44% of women and 58.28% of men. Consumption of vegetables in a higher amount (3 – 4 pieces a day) was observed in 23.81% of women and 12.95% of men. Negative finding is that up to 30.16% of women and 28.78% of men do not consume vegetables every day. We have detected a significant effect of the consumption of vegetables on LDL cholesterol in favor of daily consumption (p <0.05) in women. Women and men who consumed fruits and vegetables daily had statistically significantly lower levels of HDL. Considering the number of fruits and vegetables consumed daily, men and women who consumed 3 – 4 pieces per day had statistically insignificantly higher level of HDL than those who consumed only 1 – 2 pieces per day.

The excessive consumption of simple sugars - particularly in form of sweetened beverages has become an enormous problem of the past decades. Numerous meta-analyzes have shown that a decreased consumption of added sugar significantly reduces body weight, while the increased intake of sugar leads to the increase in weight **(Hu, 2013).** We found significantly higher BMI (p <0.05) in men who consume sweetened beverages compared with those who consume the unsweetened ones. The consumption of sweets did not have significant effect on BMI values in men neither in women, which were lower for less frequent consumption in both cases.

CONCLUSION

Through the research carried out, we recorded high incidence of risk factors, in particular overweight and obesity, high blood pressure and high prevalence of hypercholesterolemia and hypertriglyceridemia. More than a half of the respondents was simultaneously overweighted or obese with high blood pressure.

Nutritional factors which have a correlation with the occurrence of cardiovascular diseases include, in particular, the consumption of inappropriately selected fats with over-representation of saturated fatty acids, a lack of the protective agents, e.g. unsaturated fatty acids, fiber, vitamins and antioxidants. When assessing the nutritional history we have recorded frequent consumption of meat and meat products, insufficient consumption of fish and milk. Although fruits and vegetables are a part of daily diet of almost all patients, it is insufficient in amount of one or two pieces per day compared with the dietary recommendations.

We detected statistically non-significant differences in the effect of number of daily meals on HDL cholesterol value, which was higher in women and men who consumed 3-4 meals compared to 1 – 2 meals per day. The number of daily meals was statistically significantly reflected in the higher BMI in men who ate 1-2 times a day (BMI = 33.36 $kg.m^{-2}$) compared with men who ate 5-6 meals per day (BMI = 30.19 $kg.m^{-2}$) (p <0.05). We found lower BMI values in women with more frequent consumption of food. With the exception of the impact of vegetables consumption on lower LDL cholesterol levels in women, different frequency of monitored food consumption did not show to be statistically significant for the level of lipid profile and BMI in women neither in men.

Cardiovascular prevention should be a lifelong endeavour and more emphasis should be given to the behavioralaspects of prevention and life-long healthy life style adherence. It is therefore necessary to emphasize that without the lifestyle changes and without the improvements in control of hypertension, hyperlipidemia and diabetes, the reduction of mortality from cardiovascular diseases can not be expected

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