PREVALENCE OF DIET ATHEROGENICITY AND COEXISTENCE OF LIPID DISORDERS AND ARTERIAL HYPERTENSION AMONG 50-YEAR-OLD INHABITANTS OF WROCLAW, POLAND

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SUMMARY

Objective: The incorrect composition of a diet, its atherogenicity, is conducive to the occurrence of lipid disorders, arterial hypertension (HTN), diabetes, and metabolic syndrome (MetS). The aim of the study was to evaluate the prevalence of incorrect anthropometric and biochemical parameters as well as diet atherogenicity.

Methods: The study group included 1,520 adults (880 women, 640 men). The nutritional status evaluation was based on respondents' BMI and waist circumference. The diet atherogenicity was estimated using Keys Index (KI) and P/S ratio. Total cholesterol (TCh), LDL cholesterol as well as triglycerides (TG) concentration in blood serum were also evaluated.

Results: In 56.8% of women and 60.8% of men waist circumference exceeded referential values. The diets of 71.4% of women and 87.3% of men were atherogenic. HTN was observed in 64.1% of the study population. Hypercholesterolaemia was found in approximately 72% of the respondents. The increased LDL cholesterol concentration were found in 57.5% of women and 64.5% of men. Abnormal concentration of HDL cholesterol occurred among approximately 20% of respondents. Hypertriglyceridaemia was recognised in 26% of women and 44% of men. In the group of women and men with HTN, mean values, i.e. BMI, waist circumference and TG (with TCh concentration additionally noted in men) were found as significant. Normal lipid profile and arterial pressure values were observed in 6.6% of the population.

Conclusions: In the diets of men with HTN were observed higher values of KI compared to group without HTN. No significant differences were found in the frequency of occurrence of the analysed parameters either among the group of women with HTN or without it. In the group of men with HTN, the abnormal BMI, waist circumference and TG occurred more frequently.

Key words: diet atherogenicity, hypertension, obesity, lipid profile

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INTRODUCTION

The major risk factors for cardiovascular disease (CVD) includes: arterial hypertension (HTN), lipid disorders, abdominal obesity, and the co-occurrence of these conditions, all of which can lead to the development of metabolic syndrome (MetS) (1, 2). The mentioned risk factors can be influenced by changes in the diet composition. Diets high in omega-6 polyunsaturated fatty acids (PUFAs) generate the production of free radicals and the intensification of oxidative processes in the body. Converse to the referential amounts, the amounts of saturated fatty acids (SFA), PUFAs and cholesterol in the diet determining its atherogenicity simultaneously influence the lipid profile and the occurrence of HTN (3, 4).

The incidence of HTN within the general population is approximately 30–45%, and increases considerably with age (5). Due to its high prevalence, unsatisfactory detection, the low effectiveness of drug treatment, and the risk of death from major cardiac and cardiovascular incidents, changes in lifestyle and diet play an important role in primary and secondary prevention (5, 6).

A proper diet (actively antiatherosclerotic) is rich in monounsaturated fatty acids (MUFA) and omega-3 PUFA, and has the beneficial effect of reducing the incidence of CVD by lowering blood pressure and serum lipids and reducing the tendency towards thrombotic complications (6–8).

A risk factor which increased the risk of HTN is obesity, especially visceral obesity. Visceral adipocytes and adipose tissue are extremely active metabolically and secrete substances into the blood, which increase insulin resistance and induce chronic inflammation and deep vein thrombosis. All of them participate in the pathogenesis of HTN (9, 10).

Screening tests to diagnose HTN and lipid profile disorders, together with the assessment of dietary atherogenicity and the presence of dietary risk factors, should be considered for men

≥40 years of age and women ≥50 years of age. Modifying the diet can be an important element in the prevention and treatment of HTN and dyslipidaemia.

The aim of this study was to compare the incidence of abnormal anthropometric and biochemical parameters and diet atherogenicity in 50-year old residents of Wroclaw with and without HTN.

MATERIALS AND METHODS

The study group consisted of Wroclaw residents, who in 2008 took part in the Programme for the Prevention of Cardiovascular Disease organized by the Health Department of the Municipal Office in Wroclaw. Participants aged 50 years were randomly selected from the social security registry. The study included 1,520 respondents (880 women and 640 men). The nutritional status of the population was evaluated anthropometrically by waist circumference and by calculating body mass index (BMI) (11). Normal values of waist circumference in the surveyed men and women were considered as ≤80 cm and ≤94 cm, respectively (8). The anthropometric characteristics of the study population are presented in Table 1.

In order to assess the atherogenicity of daily food intake (DFI) a P/S ratio was calculated and expressed as the relation of PUFA (g) to SFA (g) and as Keys Index (KI) (12). The KI value was calculated according to the formula:

$$KI = 1.35 \times (2 \times \%SFA - \%PUFA) + 1.5\sqrt{(chol/1{,}000\ kcal)}$$

% SFA – energy intake of saturated fatty acids in a subject's diet (%)
% PUFA – energy intake of polyunsaturated fatty acids in a subject's diet (%)
Chol/1,000 kcal – dietary cholesterol (mg) per 1,000 kcal

In order to assess atherogenicity of the diet, the average model KI was determined (modKI) by taking into account energy demand for a given age group and a given level of physical activity for the men and women studied. Assuming that the energy share from SFA in DFI was equal to 10%, while the share of energy from PUFA was equal to 8%, the average modKI for women was 35.0 ± 0.8 and for men 33.3 ± 0.7. Designated modKI was compared to the ratio calculated for the study group. Average atherogenic values in the study group of men and women are presented in Table 1.

According to the definitions of HTN developed by the International Diabetes Federation (IDF), the American Heart Association (AHA) and the National Heart, Lung and Blood Institute (NHLBI) (2009) as well as that of the National Cholesterol Education Programme – Adult Treatment Panel III (NCEP-ATP III), HTN is diagnosed when systolic blood pressure (SBP) is ≥130 mm Hg and/or diastolic blood pressure (DPB) is ≥85 mm Hg (1, 13). Measurements for SBP and DPB in subjects were taken twice, the results are shown in Table 1.

Determination of total cholesterol (TCh), low-density cholesterol (LDL), high-density cholesterol (HDL), and triglycerides (TG) concentration in serum were carried out by laboratory analyses for all patients studied. TCh was determined by the enzymatic colorimetric method. HDL cholesterol was determined by the homogeneous enzymatic colorimetric method. TG concentration in serum was determined through the lipoprotein lipase in reaction to the decomposition of fatty acids and glycerol. The concentration of LDL cholesterol was calculated using the Friedewald formula (14) for subjects found to have TG below 400 mg/dl:

$$LDL = \text{total chol.} - \text{chol. HDL} - (TG/5)\ (mg/dl)$$

LDL – low density lipoproteins (mg/dl)
HDL – high density liporpoteins (mg/dl)
TG – triglicerides (mg/dl)

In clinical practice, dyslipidaemia is defined on the basis of laboratory test results: hypercholesterolaemia ≥190 mg/dl and/or LDL ≥115 mg/dl, and HDL-cholesterol <40 mg/dl in men, and <50 mg/dl in women (1). The recommended value of lipids concentration was considered as: TCh <190 mg/dl, LDL cholesterol <115 mg/dl, HDL cholesterol ≥40 mg/dl for men and ≥50 mg/dl for women, and TG <150 mg/dl (1, 13). The average concentra-

Table 1. *Comparison of the average values of anthropometric parameters, atherogenicity indicators, arterial blood pressure (SBP, DPB), and serum concentration of TCh, LDL, HDL and TG of study population (N = 1,520)*

Variables	Unit	Women (n = 880)		Men (n = 640)	
		X ± SD	M	X ± SD	M
BMI	kg/m²	26.1 ± 4.5	25.2	27.3 ± 4.1*	27.1
Waist circumference	cm	82.9 ± 11.2	81.0	96.6 ± 11.1*	96.0
KI		45.8 ± 16.4	44.4	46.4 ± 12.3*	46.6
P/S		0.5 ± 0.4	0.4	0.6 ± 0.4	0.5
SBP	mmHg	131.8 ± 17.4	130.5	140.0 ± 18.0*	139.0
DBP	mmHg	80.7 ± 10.2	80.0	85.2 ± 11.2*	84.0
TCh	mg/dl	211.8 ± 37.7	207.4	211.2 ± 38.6	209.0
LDL-cholesterol	mg/dl	123.6 ± 33.9	120.6	128.5 ± 33.9*	126.9
HDL-cholesterol	mg/dl	63.1 ± 15.6	61.9	51.0 ± 13.7*	49.1
TG	mg/dl	127.0 ± 71.2	108.0	165.4 ± 107.6*	139.9

X ± SD – arithmetic mean ± standard deviation; M – median; BMI – body mass index; KI – Key's Index; P/S – polyunsaturated/saturated fatty acids; SBP – systolic blood pressure; DBP – diastolic blood pressure; TCh – total cholesterol; LDL – low-density lipoproteins; HDL – high-density lipoproteins; TG – triglycerides; *p < 0.05 (statistically significant) tions of lipid profile parameters and blood pressure readings in the study population are presented in Table 1.

Statistical Analysis

Statistical analysis was performed using the Statistica 10.0 GB program by StatSoft Inc. USA. Continuous variables are presented as mean ± standard deviation (X ± SD). Non-normative distribution variables were subjected to a non-parametric U Mann-Whitney test or a Kruskall-Wallis test. The normality of data distribution was verified via Shapiro-Wilk test. Correlations between ordinal and nominal variables were assessed through a Chi^2 test. The level of statistical significance was set at $p < 0.05$.

RESULTS

The average values of BMI calculated for the study group of men and women indicated a prevalence of overweight (Table 1). Significantly higher BMI was observed in men compared to women (27.3 vs. 26.1 kg/m^2, $p < 0.0001$). According to BMI, normal body weight was observed in 47.2% of women and 29.4% of men, while 33.4% of women and 49.5% of men were overweight. Obesity was observed in 17.8% of women and 19.8% of men.

Considerably higher values of waist circumference were found among men compared to women (96.6 vs. 82.9 cm, $p < 0.05$) (Table 1). Based on the waist circumference values, it was found that 56.8% of women and 60.8% of men have an increased risk of metabolic complications due to the development of abdominal obesity (Table 2).

The approximate value of P/S ratio, calculated for the diets of women and men was 0.5 and 0.6, respectively, which was below the optimal value ≥ 1.0. Considerably higher KI values were recorded for the diets of men compared to women (46.4 vs. 45.8; $p = 0.0372$) (Table 1). The normal value of KI for diets was found among 12.7% of men and 28.6% of women (Table 2).

The average values of SBP were significantly higher among men than in the group of women (140.0 vs. 131.8 mm Hg,

Table 2. *Prevalence of abnormal anthropometric and biochemical parameters and dietary atherogenicity among study population (N = 1,520)*

Variable		Unit	Women (n = 880)	Men (n = 640)
			n (%)	n (%)
BMI	> 24.9	kg/m^2	458 (52.0)	451 (70.5)
Waist circumference	W ≥ 80; M ≥ 94	cm	500 (56.8)	389 (60.8)
KI	W > 35.0; M > 33.0		628 (71.4)	559 (87.3)
P/S	< 1.0		777 (88.3)	565 (88.3)
TCh	≥ 190	mg/dl	643 (73.1)	454 (70.9)
LDL-cholesterol	≥ 115	mg/dl	506 (57.5)	413 (64.5)
HDL-cholesterol	W < 50; M < 40	mg/dl	170 (19.3)	136 (21.3)
TG	≥ 150		229 (26.0)	281 (44.0)

W – women; M – men; BMI – body mass index; KI – Key's Index; P/S – polyunsaturated/saturated fatty acids; LDL – low-density lipoproteins; HDL – high-density lipoproteins; TG – triglycerides

Table 3. *Comparison of the average values of anthropometric parameters, atherogenicity indicators and biochemical parameters among respondents with and without HTN (N = 1,520)*

Variable	Unit	Women (n = 880)		Men (n = 640)	
		Group I n = 502	Group II n = 378	Group I n = 473	Group II n = 167
		X ± SD	X ± SD	X ± SD	X ± SD
BMI	kg/m^2	27.0 ± 4.8*	24.8 ± 3.7	28.0 ± 4.1*	25.4 ± 3.4
Waist circumference	cm	85.2 ± 11.6*	80.0 ± 10.0	98.2 ± 11.1*	92.0 ± 9.8
KI		44.8 ± 16.3	47.1 ± 16.6	46.5 ± 12.3	45.9 ± 12.4
P/S		0.6 ± 0.4	0.5 ± 0.3	0.5 ± 0.4	0.6 ± 0.3
TCh	mg/dl	212.6 ± 38.4	210.8 ± 36.9	213.9 ± 39.4*	203.8 ± 35.0
LDL-cholesterol	mg/dl	123.3 ± 34.7	123.3 ± 33.7	128.0 ± 36.0	124.8 ± 31.7
HDL-cholesterol	mg/dl	62.0 ± 16.0	64.6 ± 14.8	50.7 ± 13.4	51.6 ± 14.5
TG	mg/dl	136.4 ± 79.5*	114.5 ± 55.9	175.5 ± 117.7*	136.9 ± 63.5

HTN – arterial hypertension; group I – people with arterial hypertension; group II – people without arterial hypertension; n – number of subjects ; X ± SD – arithmetic mean ± standard deviation; BMI – body mass index; KI – Key's Index; P/S – polyunsaturated/saturated fatty acids; TCh – total cholesterol; LDL – low-density lipoproteins; HDL – high-density lipoproteins; TG – triglycerides; *p < 0.05 (statistically significant) p<0.0001). Similar relationships were shown for the average values of DBP among men and women (85.2 vs. 80,7 mm Hg, p<0.0001) (Table 1). HTN was found among 64.1% of the population (Table 3).

The average concentration of TCh in blood serum, which was approximately 211 mg/dl for both groups, indicated the presence of hypercholesterolaemia (Table 1). Among respondents who had diagnosed hypercholesterolaemia, the largest number constituted a group with concentration of total blood serum cholesterol ranging between 190–250 mg/dl (59.5% of women, 56.2% of men). The concentration of total cholesterol exceeding 250 mg/dl was found in 13.6% of women and 14.7% of men (Fig. 1).

Considerable differences were found between women and men (123.6 vs. 128.5 mg/dl, p=0.0074), in terms of the average concentration of LDL cholesterol in blood serum (Table 1). Increased LDL cholesterol concentration was observed among 57.5% of women and 64.5% of men (Table 2). The average concentration of HDL cholesterol in the blood serum of men was significantly lower than in women (51.0 vs. 63.1 mg/dl, p<0.0001). However, among both women and men, these values were not lower than recommended (Table 1). Abnormal concentrations of HDL cholesterol were observed among 19.3% of women and 21.3% of men (Table 2). Considerable differences among women and men were observed in TG concentration (165.4 vs. 127.0 mg/dl, p<0.0001) (Table 1). Hypertriglyceridaemia was identified among 26% of women and 44% of men (Table 2).

HTN was identified among 57% of women (Table 3). The average value of arterial pressure (SBP/DBP) in the group with HTN (group I) was 143/87 mm Hg, while in the group without HTN (group II), the average value of arterial pressure (SBP/DBP) was 117/73 mm Hg. Abnormal values of SBP and DBP were discovered among 39% and 6.4% of women with HTN, respectively. Among 54.6% of women with HTN abnormal values of both SBP and DPB were identified.

The presence of HTN was observed among 74% of men (Table 3). The average value of arterial pressure (SBP/DBP) in group I was 147/89 mm Hg, while in the group II the average arterial pressure (SBP/DBP) was 119/75 mm Hg. Abnormal values of SBP and DBP were identified among 35.3% and 3% of men with HTN, respectively. Abnormal values of both SBP and DPB were found among 61.7% of men with HTN.

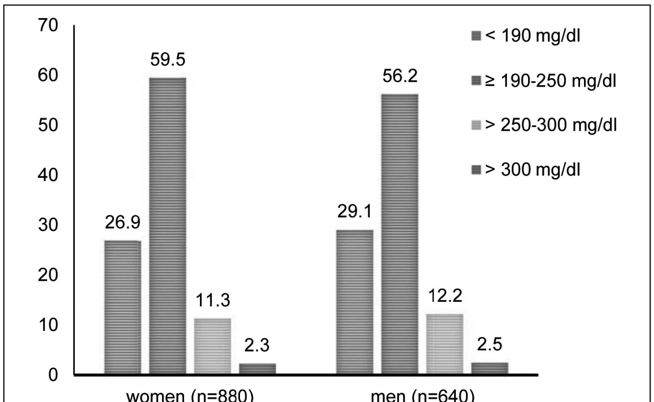

Fig. 1. *Prevalence of hypercholesterolaemia (TCh mg/dl) in the study population (%).*

Table 4. *Prevalence of abnormal anthropometric and biochemical parameters and dietary atherogenicity within individuals with and without HTN among study population (N=1,520)*

Variable		Unit	Women (n = 880)				I vs. II	Men (n = 640)				I vs. II
			Group I (n = 502)		Group II (n = 378)		p	Group I (n = 473)		Group II (n = 167)		p
			n	%	n	%		n	%	n	%	
BMI	>24,9	kg/m²	306	61.0	152	40.2	Si	371	78.4	80	47.9	<0.0001
Waist circumference	K≥ 80; M ≥94	cm	321	63.9	179	47.4	Si	316	66.8	73	43.7	<0.0001
KI	K> 35.0; M >33.0		340	67.7	288	76.2	Si	421	89.0	138	82.6	0.0333
P/S	<1.0		435	86.7	342	90.5	Si	418	88.4	147	88.0	Si
TCh	≥190	mg/dl	359	71.5	284	75.1	Si	345	72.9	109	65.3	0.0606
LDL cholesterol	≥115	mg/dl	290	57.8	216	57.1	Si	306	64.7	107	64.1	Si
HDL cholesterol	K< 50; M <40	mg/dl	117	23.3	53	14.0	Si	101	21.4	35	21.0	Si
TG	≥150	mg/dl	156	31.1	73	19.3	Si	224	47.4	57	34.1	0.0031

HTN – arterial hypertension; n – number of subjects; group I – people with arterial hypertension; group II – people without arterial hypertension; BMI – body mass index; KI – Key's Index; P/S – polyunsaturated/saturated fatty acids; TCh – total cholesterol; LDL – low-density lipoproteins; HDL – high-density lipoproteins; TG – triglycerides; Si – statistically insignificant

Considerably higher values of BMI were demonstrated in the group with HTN contrary to those without HTN (group I vs. group II) among both women (27.0 vs. 24.8 kg/m^2, $p<0.0001$) and men (28.0 vs. 25.4 kg/m^2, $p<0.0001$). Similar relationships between groups I and II were reported in terms of waist circumference among both women (85.2 vs. 80.0 cm, $p<0.0001$) and men (98.2 vs. 92.0 cm, $p<0.0001$). Abnormal values of BMI and waist circumference were observed in approximately 62% of women with HTN. Likewise, abnormal values of BMI and waist circumference were observed in 78.4% and 66.8% of men with HTN, respectively (Table 4).

No significant differences were found in average values of dietary atherogenicity indexes of both the women and men of groups I and II (Table 3). Abnormal values of KI and P/S, calculated for the diets of women with HTN, occurred among 67.7% and 86.7% of women, respectively. In the diets of men with HTN, abnormal values of both KI as well as P/S were found in 89% of the study group subjects (Table 4).

The significant differences were observed in TCh concentrations in blood serum, between the men of groups I and II (213.9 vs. 203.8 mg/dl, $p=0.0026$) (Table 3). Abnormal values of TCh concentration were identified among 71.5% of women with HTN and 72.9% of men with HTN. Among women and men without HTN, the percentage of people with elevated concentrations of TCh was 75.1% and 65.3%, respectively (Table 4).

There were no significant differences in LDL and HDL cholesterol concentration between the study groups with or without HTN. The average values of LDL cholesterol concentrations exceeded referential values in the blood serum of women (group I – 57.8%, group II – 57.1%) and men (group I – 64.7%, group II – 64.1%) (Table 4).

The frequency of hypertriglyceridaemia was higher among the population of women with HTN in comparison with the group II (31.1 vs. 19.3%). More significant differences in the occurrence of hypertriglyceridaemia were identified among men with HTN compared to those without HTN (47.4 vs. 34.1%) (Table 4). Statistically significant differences were identified in the average concentration of TG between groups I and II, among both women (136.4 vs. 114.5 mg/dl, $p<0.0001$), and men (175.5 vs. 136.9 mg/dl, $p<0.0001$) (Table 3).

Among the population of 50-year olds, those with a normal lipid profile and arterial pressure values constituted 6.6% of the total number of participants (8.2% of women and 4.4% of men).

DISCUSSION

Overweight and obesity constitute an essential risk factor in the development of HTN, resulting from lifestyle and dietary habits. In particular, a high risk for the development of metabolic complications occurs in individuals with abdominal obesity. In the ATTICA Study (9), it was revealed that elevated values of waist circumference and BMI were considered the most significant risk factors in the development of HTN. In the present study, we demonstrated abnormalities in the nutritional status based on BMI, which indicated the occurrence of overweight and obesity among a substantial percentage of both women and men surveyed. A relation between the co-occurrence of excessive body weight and HTN was identified. The abnormal average values of BMI and waist circumference were observed among those with HTN, compared to those with correct arterial pressure. The high value of waist circumference is considered a predictive factor in the development of HTN, indicating the pattern of distribution of adipose tissue. Various studies performed by many authors have indicated that abdominal obesity is the key factor leading to formation of inflammatory, oxidative, hemodynamical, and prothrombotic disorders as well as HTN (9, 15). The above findings are consistent with the results of other studies (16, 17). In the Pol-MONICA study (18), overweight or obesity were found among 67% of men and 75% of women with HTN. In accordance with data from the Pol-MONICA BIS study (19), the frequency of HTN among obese respondents was 70% among men and 65% in women. Reducing body weight by 5 kg results in a moderate antihypertensive effect and has a positive influence on risk factors such as insulin resistance, diabetes, hyperlipidaemia, and ventricular hypertrophy. On average, a reduction of SBP and DBP by 4.4 and 3.6 mm Hg, is estimated to result in a reduction of body weight by 5.1 kg (20).

Any increase in arterial pressure is related to increase in CVD risk, provided that this trend is continuous and even escalating. More than a half of the women and men surveyed showed increased values of both SBP and DBP. The factors mentioned independently influence CVD risk, yet regardless of age and gender, systolic pressure is considered the stronger prognostic factor. Even a slight increase in SBP, in the range 140–160 mm Hg, entails a two fold increase in mortality in comparison with systolic pressure below 140 mm Hg (6).

Thus, a considerable element of HTN therapy is the monitoring of dietary habits in the Polish population. A diet abundant in food products being the source of cholesterol and SFA is a significant factor increasing the risk of atherogenesis, HTN and obesity. A high intake of these foods is conducive to hypercholesterolaemia, and can also cause impairment of the endothelium of vessels through the release of oxygen free radicals (4, 21). Demonstrated abnormal values of P/S ratio and KI in diets of the 50-year olds surveyed are characteristic of the populations of Western countries, who are characterised by a high intake of animal fats and a low intake of vegetables and fish. Such dietary habits impair the lipid profile in blood serum contributing to the development of atherogenic changes and HTN. Thus, the fundamental goal of treatment in patients with HTN is the control of body weight, the introduction of regular physical activity and changes in dietary habits (9).

The activation of inflammatory processes, which play a key role in the development of HTN and obesity, is related to the presence of both hypercholesterolaemia as well as hypertriglyceridaemia, accompanied by a reduction in the HDL cholesterol concentration in blood serum, resulting in the development of atherogenic changes.

An increased concentration of TCh and TG in blood serum as well as HTN constitute independent risk factors for the development of CVD. In the research mentioned above, a considerably higher concentration of TG among the individuals with HTN, in comparison to those without HTN, has been demonstrated in both women and men. Furthermore, a significantly higher concentration of TCh was found among men with HTN compared to those without HTN. The results are in line with observations of other epidemiological studies relating to lipid disorders and obesity among individuals with HTN. Hoffmann et al. (22) demonstrated that among the parameters of lipid metabolism only TG concentration was higher in the HTN group. As in the present study, Strażyńska et al. (23) also failed to indicate significant differences between the group with HTN and the group without HTN, concerning the values of concentrations of LDL and HDL cholesterol. In contrast, considerably higher values of TG and BMI were shown in the HTN group than in the group without HTN.

The average values of LDL cholesterol concentration indicate the presence of dyslipidaemia among respondents. Similar results were obtained by other authors (19, 24). It should be emphasised that LDL cholesterol is not homogenous and consists of fractions of different size, density and chemical composition as well as proatherogenetic potential (25). The close relationship between the TCh concentration in blood serum, concentrations of LDL cholesterol and the risk for ischaemic heart disease (IHD), observed in epidemiological and clinical studies, is strong evidence of the atherogenic activity of LDL cholesterol. The lowering of LDL cholesterol concentration is related to a reduction in the risk of developing HTN and IHD (26).

The HDL cholesterol is regarded as an important prognostic factor for IHD. As the authors of numerous studies have demonstrated, high LDL concentration alongside low HDL concentrations influence the progression of atherosclerosis as well as incidence of IHD. According to the authors of the Framingham study (27), a decline in HDL concentration by 4 mg/dl can give rise to the incidence of IHD by up to 10%, while increasing HDL concentration by 1 mg/dl can lower mortality from IHD by 6% regardless of LDL concentration. In the present study, the average values of HDL cholesterol exceeded referential values within both groups examined, which gives an optimistic prognosis. Based on the research conducted by Sharrett et al. (28) low concentrations of HDL (<35 mg/dl) are considered frequent. An important element in diagnosing and treating dyslipidaemia is the interaction between metabolism of HDL and TG. The high density lipoproteins are receivers of substances released during TG lipolysis, which leads to neutralization of their atherogenic activity (26).

Dyslipidaemia and HTN are the causes of dysfunction in the endothelium cells of blood vessels, which adversely change the secretion of substances responsible for vasodilation and vasoconstriction (29). The co-occurrence of HTN with other disorders of lipid profile accelerates the development of atheromatous lesions, and as a consequence, the development of atherosclerosis and IHD. When compared to the group without HTN, increased values of total cholesterol concentration, reduced concentration of HDL cholesterol fraction, and increased TG levels were observed among men with HTN. However, in women with HTN increased concentrations of LDL cholesterol fraction as well as TG were identified more often than among those without HTN. The research of other authors has confirmed a higher incidence of lipid profile disorders among individuals with HTN (9, 30).

The co-occurrence of HTN, dyslipoproteinaemia (a higher concentration of TG and lowered concentration of HDL cholesterol fraction), and the prevalence of abdominal obesity predisposes patients to MetS (1, 2). Among the numerous risk factors associated with HTN, dyslipidaemia, obesity and the resulting MetS, particular attention should be paid to socio-demographic factors as well as factors related to lifestyle and diet.

CONCLUSIONS

Crucial to reducing the incidence of HTN in the study population is the limitation of risk factors such as overweight and obesity. The increased values of BMI and waist circumference, as well as abnormal concentration of TCh and TG in the studied men were correlated with HTN. With regard to gender as an independent risk factor for CVD it may be assumed that men are more susceptible to its occurrence.

The coexistence of HTN, lipid disorders and obesity can significantly accelerate the progression of atherosclerosis and its complications in the study population.

It was also shown that most studied diets of women and men were atherogenic. Dietary modifications resulting in the reduction of SFA and n-6 PUFAs content in the diet, in addition to the introduction of n-3 PUFAs, may have a beneficial effect on reducing the risk of CVD. The proposed modifications of diet composition could have a significant impact on obtaining normal blood pressure and lipid profile in the studied 50-year old population.

Nutrition education in the prevention of CVD is necessary. The benefits of body weight reduction and a diet poor in products containing significant amounts of SFA and dietary cholesterol should be highlighted when designing health promotion and nutrition education programmes.

REFERENCES

1. Kassi E, Pervanidou P, Kaltsas G, Chrousos G. Metabolic syndrome: definitions and controversies. BMC Med. 2011 May 5;9:48. doi: 10.1186/1741-7015-9-48.
2. Mendizábal Y, Llorens S, Nava E. Hypertension in metabolic syndrome: vascular pathophysiology. Int J Hypertens. 2013;2013:230868. doi: 10.1155/2013/230868.
3. Roberts CK, Barnard RJ, Sindhu RK, Jurczak M, Ehdaie A, Vaziri ND. Oxidative stress and dysregulation of NAD(P)H oxidase and antioxidant enzymes in diet-induced metabolic syndrome. Metabolism. 2006 Jul;55(7):928-34.
4. Dharwadkar SM, Agate AA, Singh RB. Study of relationship between serum atherogenic lipid parameters, oxidative stress biomarkers and antioxidant vitamins in hypertension. Int J Biotechnol Biosci. 2012;2(3):190-6.
5. Tykarski A, Podolec P, Kopeć G, Pająk A, Kawecka-Jaszcz K, Zdrojewski T, et al. Consensus of the Editorial Board of the Polish Forum of Prevention of the Cardiovascular Diseases regarding hypertension. Forum Profilaktyki. 2006;(4):1. (In Polish.)
6. Catapano AL, Graham I, De Backer G, Wiklund O, Chapman MJ, Drexel H, et al. 2016 ESC/EAS Guidelines for the Management of Dyslipidaemias: The Task Force for the Management of Dyslipidaemias of the European Society of Cardiology (ESC) and European Atherosclerosis Society (EAS) Developed with the special contribution of the European Asssocciation for Cardiovascular Prevention & Rehabilitation (EACPR). Atherosclerosis. 2016 Oct;253:281-344.
7. Wożakowska-Kapłoń B, Salwa P, Siebert J. New European guidelines for the management of arterial hypertension- do they really influence clinical practice? Folia Cardiol. 2014;9(1):33-53. (In Polish.)
8. Perk J, De Backer G, Gohlke H, Graham I, Reiner Z, Verschuren M, et al.; European Association for Cardiovascular Prevention & Rehabilitation (EACPR).; ESC Committee for Practice Guidelines (CPG). European Guidelines on cardiovascular disease prevention in clinical practice (version 2012). The Fifth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of nine societies and by invited experts). Eur Heart J. 2012 Jul;33(13):1635-701.
9. Panagiotakos DB, Pitsavos C, Chrysohoou C, Skoumas I, Stefanadis C; ATTICA Study. Five-year incidence of cardiovascular disease and its predictors in Greece: the ATTICA study. Vasc Med. 2008;13(2):113-21.

10. Simonds SE, Cowley MA. Hypertension in obesity: is leptin the culprit? Trends Neurosci. 2013 Feb;36(2):121-32.
11. World Health Organization. Obesity: preventing and managing the global epidemic. Report of a WHO Consultation. WHO Technical Report Series 894. Geneva: WHO; 2000.
12. Keys A, Anderson JT, Grande F. Serum cholesterol response to changes in the diet: IV. Particular saturated fatty acids in the diet. Metabolism. 1965 Jul;14(7):776-87.
13. Mamcarz A, Podolec P, Kopeć G, Czarnecka D, Rynkiewicz A, Stańczyk J, et al. Consensus of the PFP Working Group concerning the metabolic syndrome. Forum Profilaktyki. 2009;(2):1. (In Polish.)
14. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. Clin Chem. 1972 Jun;18(6):499-502.
15. Panagiotakos DB, Pitsavos C, Lentzas Y, Chrysohoou C, Stefanadis C. Five-year incidence of hypertension and its determinants: the ATTICA study. J Hum Hypertens. 2007 Aug;21(8):686-8.
16. Khaw KT, Wareham N, Bingham S, Welch A, Luben R, Day N. Combined impact of health behaviours and mortality in men and women: the EPIC-Norfolk prospective population study. PLoS Med. 2008 Jan 8;5(1):e12. doi: 10.1371/journal.pmed.0050012.
17. Zatońska K, Campos H, Ilow R, Janik-Koncewicz K, Różańska D, Regulska-Ilow B, et al. Dietary intake and adipose tissue level of specific fatty acids in a selected group from the Lower Silesia population. Ann Agric Environ Med. 2012;19(3):389-94.
18. Rywik SL, Davis CE, Pajak A, Broda G, Folsom AR, Kawalec E, et al. Poland and U.S. collaborative study on cardiovascular epidemiology hypertension in the community: prevalence, awareness, treatment, and control of hypertension in the Pol-MONICA Project and the U.S. Atherosclerosis Risk in Communities Study. Ann Epidemiol. 1998 Jan;8(1):3-13.
19. Rywik S, Piotrowski W, Pająk A, Broda G, Rywik T. Relationship between metabolic disturbances and overweight or obesity in a random sample of Polish population aged 20-74 years - the Pol-MONICA Bis Project. Med Metabol. 2003;7(2):16-24. (In Polish.)
20. Neter JE, Stam BE, Kok FJ, Grobbee DE, Geleijnse JM. Influence of weight reduction on blood pressure: a meta-analysis of randomized controlled trials. Hypertension. 2003 Nov;42(5):878-84.
21. Beasley J, Viswanathan S, Wylie-Rosett J. Associations between change in DASH diet scores and CVD risk factors in the PREMIER Trial. FASEB J. 2014;28(Suppl. 369.1).
22. Hoffmann K, Bryl W, Strażyńska A, Miczke A, Cymerys M, Kramer L, et al. The assessment of adiponectin and insulin concentrations selected metabolic parameters, family history and anthropometric factors in young population with primary arterial hypertension. Nadciśnienie Tętnicze. 2008;12(5):359-66. (In Polish.)
23. Strażyńska A, Bryl W, Hoffmann K, Miczke A, Cymerys M, Rzesoś A, et al. Leptin and insulin concentrations, lipid profile and anthropometric parameters in young adults with primary arterial hypertension. Nadciśnienie Tętnicze. 2008;12(6):424-31. (In Polish.)
24. Wolańska D, Kłosiewicz- Latoszek L. Fatty acids intake and serum lipids profile in overweighted and obese adults. Rocz Panstw Zakl Hig. 2012;63(2):155-62. (In Polish.)
25. Carlsson CM, Nondahl DM, Klein BE, McBride PE, Sager MA, Schubert CR, et al. Increased atherogenic lipoproteins are associated with cognitive impairment: effects of statins and subclinical atherosclerosis. Alzheimer Dis Assoc Disord. 2009 Jan-Mar;23(1):11-7.
26. Fujioka Y, Ishikawa Y. Remnant lipoproteins as strong key particles to atherogenesis. J Atheroscler Thromb. 2009 Jun;16(3):145-54.
27. Gordon T, Castelli WP, Hjortland MC, Kannel WB, Dawber TR. High density lipoprotein as a protective factor against coronary heart disease. The Framingham Study. Am J Med. 1977 May;62(5):707-14.
28. Sharrett AR, Ballantyne CM, Coady SA, Heiss G, Sorlie PD, Catellier D, et al.; Atherosclerosis Risk in Communities Study Group. Coronary heart disease prediction from lipoprotein cholesterol levels, triglycerides, lipoprotein(a), apolipoproteins A-I and B, and HDL density subfractions: The Atherosclerosis Risk in Communities (ARIC) Study. Circulation. 2001 Sep 4;104(10):1108-13.
29. Creager MA, Gallagher SJ, Girerd XJ, Coleman SM, Dazu VJ, Cooke JP. L-arginine improves endothelium-dependent vasodilation in hypercholesterolemic humans. J Clin Invest. 1992;90(4):1248-53.
30. Dash SC, Mishra J, Patro S, Mishra S, Dash DD. Prevalence of diabetes, hypertension, renal dysfunction and hyperlipidemia among doctors of a Medical College in Odisha. Int J Physiol. 2013;1(2):130-4.

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