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Evaluation of selected lipid parameters and blood pressure in ethnically-homogenous population of middle-aged persons, depending on gender, age and body mass

Research Article

Adam Buciński[1*], Jerzy Romaszko[2], Ryszard Targoński[3], Leszek Cichowski[4], Ewa Romaszko[5], Andrzej Zakrzewski[6], Małgorzata Wnuk[1]

[1] *Department of Biopharmacy, Nicolaus Copernicus University in Toruń, Collegium Medicum in Bydgoszcz, 85-094 Bydgoszcz, Poland*

[2] *NZOZ Pantamed Sp z o.o. in Olsztyn, 10-461 Olsztyn, Poland*

[3] *Department of Nursing, Faculty of Medical Sciences, University of Warmia and Mazury in Olsztyn, 10-561 Olsztyn, Poland*

[4] *Cardiology and Internal Diseases Ward, City Complex of Hospitals in Olsztyn, 10-045 Olsztyn, Poland*

[5] *NZOZ Atarax in Olsztyn, 10-117 Olsztyn, Poland*

[6] *Warminsko-Mazurski Provincial Branch of the National Health Fund, 10-561 Olsztyn, Poland*

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Abstract: The study is a retrospective analysis of data obtained from a cardiovascular disease prevention program financed by the National Health Fund (Poland). The aim of the study was to evaluate the population to demonstrate the prevalence of favourable and unfavourable lipid parameters and blood pressure values depending on age and BMI. A total of 2,616 subjects were included in the study (811 men and 1805 women aged between 35 and 55 years of age) who perceived themselves as completely healthy individuals and in whom no cardiovascular disease or diabetes mellitus had been diagnosed. We evaluated blood pressure values, body weight, height, BMI, fasting glucose, total cholesterol, triglycerides, HDL and LDL in the serum of venous blood. The above-mentioned parameters were compared in women and men depending on BMI and age. It was demonstrated that the epidemiological situation of women in the analysed age group, regardless of the studied parameter and method of its evaluation, is much more favourable than that of men. We have demonstrated that evaluation of the analysed lipid parameters and blood pressure should be performed with consideration to gender and age. Otherwise conclusions may be obtained which are not satisfied by 75-95% of the population in a given age group. Obesity was highlighted as a factor triggering further lipid disturbances and blood pressure increase.

Keywords: *Biomedical statistics • Cardiovascular disease • Risk factors • Lipid parameter • Positive health outcomes*

* *E-mail: kizbiofarmacji@cm.umk.pl*

1. Introduction

Cardiovascular disease is the most common cause of death in Europe [1]. It is epidemiologically related to various types of risk factors. These factors are usually divided into modifiable (such as body mass, lifestyle or cholesterol levels) and non-modifiable (such as age or gender) [2]. Many analyses have focused on the correlation between the incidence of cardiovascular disease and the presence of risk factors [3,4]. It is commonly recognised that the importance of the modifiable risk factors of cardiovascular disease should be evaluated in relation to age and gender [5]. It is also commonly recognised that obesity is a major cardiovascular risk factor [6-8]. Obesity triggers the entire cascade of lipid abnormalities and the development of hypertension [9,10]. In an effort to limit this cascade, various types of programs against obesity are developed [11,12]. Most papers describing the above associations are written on the basis of population studies involving both healthy individuals and patients managed for cardiovascular disease. However, the correct planning of health policy requires not only data on negative health outcomes, such as morbidity and mortality, but also data on positive health outcomes, which are more difficult to obtain [13]. In the case of cardiovascular disease an attempt may be made to identify such outcomes and use them to describe the population health status. Positive health outcomes that are easy to monitor may include the correct, favourable values of lipid parameters and low values of blood pressure. In the evaluation of the population health status in terms of the risk for a specific disease entity, one normally employs the mean value of a parameter describing the risk for the disease of interest, such as the mean cholesterol level or systolic blood pressure in the case of cardiovascular disease. When attempting to evaluate positive parameters, quantitative evaluation seems to be a better method, which yields a percentage share of persons with positive values. This method allows one to identify groups of people which can and should be targeted by public health policy with a profit, so that the benefit is the greatest. Sometimes it also allows one to demonstrate that excessively rigorous expectations are unrealistic. The aim of the study was to evaluate the population to demonstrate the prevalence of favourable and unfavourable lipid parameters and blood pressure values depending on age and BMI.

Table 1. Group structure within gender.

Age bracket	BMI <25	BMI 25-30	BMI >30
35-41 years	Group 1	Group 4	Group 7
42-48 years	Group 2	Group 5	Group 8
49-55 years	Group 3	Group 6	Group 9

2. Material and Methods

The material consisted of retrospective data from the Cardiovascular Disease Prevention Programme implemented between 2005 and 2007 among the residents of Olsztyn, a city with a population of 175,000, in the north of Poland. A total of 2616 subjects were included in the study (811 men and 1805 women aged between 35 and 55 years) who perceived themselves as completely healthy individuals and in whom no cardiovascular disease or diabetes mellitus was diagnosed during an interview and physical examination. Subjects were invited to participate in the study by means of advertisements published on the Internet, press, radio and television. The following parameters were measured: systolic and diastolic blood pressure, body mass, height, body mass index (BMI), fasting glucose, total cholesterol, triglycerides (TG) and HDL-cholesterol (HDL) in the serum of venous blood. Height was measured with an auxanometer and body mass with medical scales, shoes off, clothes on.

The lipid profile and fasting glucose in the serum were determined using the following methods:

- Enzymatic colorimetric method (CHOD/PAN) with cholesterol esterase, cholesterol oxidase and 4-amino-antipyrine to determine the concentration of cholesterol.
- Homogenous colorimetric assay with the use of cholesterol esterase and PEG-modified oxidase to determine the concentration of HDL-cholesterol.
- Enzymatic colorimetric method (GPO/PAD) with glycerolphosphate oxidase and 4-amino-antipyrine to determine the concentration of triglycerides;
- Reference enzymatic method with hexokinase to determine the concentration of glucose. The assay was performed on the INTEGRA 800 system (Roche) using Roche reagents.
- LDL-cholesterol (LDL) was calculated from the Friedewald formula. The value of this parameter was not calculated in subjects with TG levels exceeding 400 mg/dl LDL [14].

Subjects were divided by gender into groups defined by BMI and age. The allocation to the groups is summarised in Table 1.

Table 2. Average values of analysed parameters with breakdown by gender.

Parameter	Female			Male			
	Avg	SD	N	Avg	SD	N	P
Glucose [mg/dl]	82.26	16.3	1805	86.81	22.98	811	<0.0001
Cholesterol [mg/dl]	207.94	38.89	1805	217.25	42.00	811	<0.0001
TG [mg/dl]	97.70	60.65	1805	145.83	115.11	811	<0.0001
HDL[mg/dl]	69.20	16.13	1805	57.86	15.45	811	<0.0001
LDL [mg/dl]	119.23	39.21	1799	131.23	39.23	787	<0.0001
Systolic blood pressure [mmHg]	120.78	13.63	1805	127.23	15.13	811	<0.0001
Diastolic blood pressure [mmHg]	77.98	9.27	1805	82.47	9.41	811	<0.0001

In the population divided as above, we compared, one by one, the mean values of the assessed parameters, followed by a comparison of the percentages of subjects in whom the lipid parameters and blood pressure values allowed to be assigned to the pool of subjects with favourable parameters. The following variants of parameter values were adopted: [15,16]

- HDL-cholesterol above 60 mg/dl
- LDL-cholesterol below 100 mg/dl
- HDL-cholesterol above 40 mg/dl in men and above 50 mg/dl in women
- LDL-cholesterol below 130 mg/dl
- systolic blood pressure below 130 mmHg and diastolic blood pressure below 85 mmHg (both conditions must be met)
- triglycerides below 150 mg/dl
- HDL-cholesterol above 60 mg/dl, LDL-cholesterol below 100 mg, systolic blood pressure below 130 mmHg and diastolic blood pressure below 85 mmHg (all the conditions must be met)
- HDL-cholesterol above 40 mg/dl in men and above 50 mg/dl in women, LDL-cholesterol below 130 mg/dl, systolic blood pressure below 130 mmHg, diastolic blood pressure below 85 mmHg, triglycerides below 150 mg/dl (all the conditions must be met)
- The analysed values were stated in mg/dl; these can be converted to mmol/l by using the following conversion factors : for glucose mg/dl x 0.0555 = mmol/l; for triglycerides - mg/dl x 0.0113 = mmol/l; for cholesterol, HDL and LDL mg/dl x 0.0259 = mmol/l.

2.1. Statistical analysis methods

Statistical analysis was performed on groups thus defined with the use of the Statistica 8.0 software package (StatSoft Inc., Tulsa, OK, USA). For all the assessed parameters, the arithmetic mean and standard deviation were calculated. The normality of the distribution of the assessed parameters was verified using the Shapiro-Wilk test [17]. When the size of a group was greater than or equal to 100, we based our conclusions on the central limit theorem. The homogenicity of variance in the study group was assessed using the Brown-Forsythe test [18]. The *P* value of 0.05 was adopted as the critical level of significance. The statistical significance between the mean values of the parameters with normal distribution and homogenous variance was tested with the t-Student test (two groups) or, in the case of comparisons between more than 2 groups with ANOVA using the *post hoc* analysis (Fisher LSD test) [19]. For variables with non-gaussian distributions (and where the use of the central limit theorem was not justified) or with different variances in the compared groups, non-parametric U Mann-Whitney and Kruskal-Wallis tests were used, respectively, with multiple comparisons [20].

3. Results

The studied population covered 2,616 people, including 1805 women (69%) aged between 35 and 55; the average age was 45.5 (SD 5,50). The average BMI for the entire population was 25.57 (SD 4.14).

In the assessed population, the mean values of total cholesterol, LDL-cholesterol, glucose, systolic blood pressure and diastolic blood pressure were lower in the group of women than men, while the mean value of HDL-cholesterol was higher in this group ($p < 0.05$). These values are summarised in Table 2.

The mean values of the analysed parameters after dividing the study population into the groups described above (Table 1) are summarised in Table 3. In the superscript, by placing the same letter, we indicated values significantly different from each other ($P \leq 0.05$).

It is important to note that the mean values of glucose in women increase as BMI or age increases. In the group of men, however, only noticeable is a difference between the oldest group with the highest BMI and the two youngest subgroups with BMI below 30. Disregarding group IX (Table 1), the remaining eight out of nine groups do not differ among themselves statistically (p<0,05). Mean values of LDL, among women correlate with age.

Table 3. Comparison of average values of selected parameters depending on gender, age and BMI.

Age bracket	FEMALE			MALE		
			Glucose [mg/dl]			
			(N; SD)			
Age [years]	BMI<25	25-29.9	BMI≥30	BMI<25	25-29.9	BMI≥30
35-41.9	*79.34^{agkmo}*	*83.24^{dno}*	*82.51*	82.25^{a}	83.33^{b}	88.26
	(321; 10.29)	*(119; 11.51)*	*(41; 8.63)*	*(72; 11.94)*	*(116; 11.92)*	*(38; 13.55)*
42-48.9	*78.44^{bhjln}*	*84.29^{elm}*	*90.71^{ghi}*	86.96	87.83	90.38
	(391; 10.71)	*(209; 24.41)*	*(87; 23.57)*	*(102; 25.94)*	*(147; 26.30)*	*(52; 27.46)*
49-55	*81.21^{ci}*	*83.44^{fjk}*	*94.42^{abcdef}*	89.68	85.00	93.12^{ab}
	(304; 14.06)	*(235; 12.54)*	*(98; 29.20)*	*(107; 36.89)*	*(135; 12.90)*	*(42; 18.36)*
			Cholesterol [mg/dl]			
			(N; SD)			
Age [years]	BMI<25	25-29.9	BMI≥30	BMI<25	25-29.9	BMI≥30
35-41.9	188.82^{aglmp}	200.34^{cjn}	200.00^{eh}	207.46^{ace}	211.53^{bd}	213.24
	(321; 30.08)	*(119; 39.11)*	*(41; 27.37)*	*(72; 37.60)*	*(116; 43.51)*	*(38; 45.61)*
42-48.9	203.95^{bkop}	208.29^{dim}	207.52^{fg}	214.66	222.82^{de}	217.83
	(391; 36.83)	*(209; 40.85)*	*(87; 38.22)*	*(102; 42.61)*	*(147; 41.59)*	*(52; 41.00)*
49-55	218.74^{no}	224.84^{fhijkl}	224.69^{abcde}	214.68	224.25^{bc}	223.60^{a}
	(304; 39.02)	*(235; 39.73)*	*(98; 36.95)*	*(107; 40.30)*	*(135; 42.64)*	*(42; 41.58)*
			TG [mg/dl]			
			(N; SD)			
Age [years]	BMI<25	25-29.9	BMI≥30	BMI<25	25-29.9	BMI≥30
35-41.9	76.16^{deikpsu}	103.15^{ahrs}	128.37^{lj}	100.61^{cfkmor}	166.61^{pr}	217.87^{ghijk}
	(321; 39.61)	*(119; 54.81)*	*(41; 133.35)*	*(72; 70.89)*	*(116; 160.07)*	*(38; 182.76)*
42-48.9	81.19^{cfilort}	108.48^{nop}	136.62^{efgh}	122.42^{bej}	159.29^{hno}	177.10^{def}
	(391; 45.98)	*(209; 54.20)*	*(87; 82.24)*	*(102; 79.51)*	*(147; 133.90)*	*(52; 112.83)*
49-55	91.01^{bgmntu}	115.71^{klm}	134.77^{abcd}	104.18^{adilnp}	144.18^{glm}	183.33^{abc}
	(304; 44.74)	*(235; 64.52)*	*(98; 90.32)*	*(107; 57.21)*	*(135; 79.15)*	*(42; 89.58)*
			HDL [mg/dl]			
			(N; SD)			
Age [years]	BMI<25	25-29.9	BMI≥30	BMI<25	25-29.9	BMI≥30
35-41.9	72.25^{bgjmp}	64.59^{nop}	64.51	63.94^{adglo}	54.40^{opr}	47.37^{ghijk}
	(321; 14.96)	*(119; 13.00)*	*(41; 14.60)*	*(72; 17.98)*	*(116; 12.24)*	*(38; 11.44)*
42-48.9	72.29^{cfilo}	64.76^{klm}	60.38^{defg}	63.17^{behmp}	55.52^{ilmn}	51.21^{def}
	(391; 15.68)	*(209; 14.24)*	*(87; 14.32)*	*(102; 18.39)*	*(147; 12.97)*	*(52; 11.35)*
49-55	73.69^{aehkn}	67.20^{dhij}	62.57^{abc}	65.20^{cfinr}	58.01^{k}	50.88^{abc}
	(304; 17.93)	*(235; 16.04)*	*(98; 15.50)*	*(107; 18.04)*	*(135; 13.02)*	*(42; 9.69)*
			LDL [mg/dl]			
			(N; SD)			
Age [years]	BMI<25	25-29.9	BMI≥30	BMI<25	25-29.9	BMI≥30
35-41.9	101.34^{cdijkmn}	115.12^{agk}	111.66^{e}	123.19^{ab}	127.67	124.21
	(321; 31.83)	*(119; 39.38)*	*(40; 24.73)*	*(71; 34.77)*	(111; 38.62)	(36; 37.44)
42-48.9	115.67^{bhln}	121.83^{fj}	118.73^{d}	128.35	136.72^{b}	132.46
	(390; 37.86)	*(209; 39.07)*	*(86; 31.86)*	*(99; 42.06)*	*(140; 40.09)*	*(49; 32.34)*
49-55	126.85^{lm}	134.50^{efghi}	135.09^{abc}	128.65	137.23^{a}	134.92
	(304; 41.79)	*(233; 41.15)*	*(97; 38.14)*	*(107; 40.29)*	*(133; 39.91)*	*(41; 39.79)*

continued Table 3. Comparison of average values of selected parameters depending on gender, age and BMI.

	Systolic blood pressure [mmHg]					
	(N; SD)					
Age [years]	BMI<25	25-29.9	BMI≥30	BMI<25	25-29.9	BMI≥30
35-41.9	115.81^{ehjlmnp}	120.57^{bn}	126.22^{ij}	122.89^{aehj}	125.74^{dgm}	129.26^{hi}
	(321; 12.12)	*(119; 10.66)*	*(41; 14.18)*	*(72; 14.30)*	*(116; 13.33)*	*(38; 12.35)*
42-48.9	117.59^{dgiko}	120.80^{afm}	126.55^{fgh}	123.52^{bfik}	127.01^{n}	130.96^{efg}
	(391; 13.05)	*(209; 12.49)*	*(87; 14.21)*	*(102; 17.36)*	*(147; 14.33)*	*(52; 15.66)*
49-55	122.17^{cop}	124.38^{kl}	129.64^{abcde}	126.31^{cl}	131.23^{jklmn}	131.67^{abcd}
	(304; 14.14)	*(235; 14.13)*	*(98; 12.80)*	*(107; 15.83)*	*(135; 14.03)*	*(42; 17.13)*
	Diastolic blood pressure [mmHg]					
	(N; SD)					
Age [years]	BMI<25	BMI 25-29.9	BMI≥30	BMI<25	BMI 25-29.9	BMI≥30
35-41.9	74.93^{flpsuxz}	78.64^{ciwx}	81.78^{mnop}	79.92^{acejl}	81.86^{h}	86.50^{efghi}
	(321; 9.06)	*(119; 8.30)*	*(41; 10.59)*	*(72; 9.50)*	*(116; 9.00)*	*(38; 7.50)*
42-48.9	75.91^{ekortwy}	78.59^{bhmtu}	81.95^{ghijkl}	80.22^{bdfkm}	81.95^{l}	84.71^{cd}
	(391; 8.70)	*(209; 8.81)*	*(87; 9.29)*	*(102; 9.99)*	*(147; 8.35)*	*(52; 9.36)*
49-55	78.64^{djnyz}	79.71^{agrs}	82.83^{abcdef}	82.83^{glm}	83.65^{jk}	84.76^{ab}
	(304; 9.58)	*(235; 8.84)*	*(98; 8.54)*	*(107; 10.31)*	*(135; 9.38)*	*(42; 9.62)*

The same letters in superscript indicate a significant statistical difference.

Among men, after excluding group I (the youngest men with the most favourable BMI), the remaining eight out of nine subgroups do not differ among themselves in a statistically significant way. Mean values of TG among women tend to increase as age and BMI increases, whereas in men, these were found to increase only as BMI increased, but not with age. It should be noted that the overall share of women with correct TG levels in subgroups with BMI <25 is high and range from 92.43% to 95.4% (Table 4). The average total cholesterol level among women rises as age increases. In men, such a correlation was only observed in subgroups with BMI 25-29.9. The average level of HDL, both in women and men, decreases with an increase in BMI, while no correlation with age can be observed. Mean values of systolic and diastolic blood pressure tend to increase as BMI and age increases for both genders.

Table 4 presents percentage of persons, in pre-defined groups, with optimum values of the analysed parameters. The overall share of men with correct values of selected lipid parameters in groups defined by age and BMI is always smaller than women. Joint evaluation of several parameters defined as positive health outcomes carried out for both women and men emphasises this difference. The size of the difference between analogous age and BMI subgroups is usually two to three folds.

Table 5 presents the percentage distribution of persons in groups defined by age and BMI.

4. Discussion

The mean values of lipid parameters, glucose and blood pressure were statistically more favourable in women than in men in the analysed age group. On the other hand, it is commonly recognised that both obesity with the resulting lipid abnormalities and hypertension develop an average of 10 years earlier in women than in men [21-24]. This relationship has been used in the development of SCORE tables [2].

Similarly to as reported by E. W. Gregg et al. and M. M. Haenle et al., we observed a considerable percentage of subjects who were overweight or obese [25,26]. Also the WOBASZ study, which included 13545 randomly selected subjects from all over Poland, revealed a significantly higher incidence of hyperlipidemia and hypertension in men versus women [27,28]. In that study, the percentage of persons with correct BMI values among women was 49.7%, and among men - 38.4%. Overweight and obesity affected 27.9% and 20.2% of women and 40.4% and 20.6% of men, respectively [30]. In our population, the percentage of persons with correct BMI among women was 54.96%, and among men - 33.91%. Being overweight and obesity affected 31.25% and 12.47% of women and 49.08% and 16.28% of men, respectively. In our view, the differences result from the fact that we analysed a population (with the exclusion of sick patients) within a strictly limited age range, much narrower than in the WOBASZ study. In the group of men, we found no increase in the share

Table 4. Percentage of persons with optimum values of the analysed parameter calculated in groups defined by BMI, age and gender.

Inclusion criterion	Age [years]	Female			Male		
		BMI<25	BMI 25-29.9	BMI≥30	BMI<25	BMI 25-29.9	BMI≥30
HDL >60	35-41.9	78.19	58.82	75.61	55.55	31.9	10.53
	42-48.9	79.28	60.29	51.72	52.94	34.69	17.31
	49-55	75.99	62.98	48.98	53.27	38.52	14.29
HDL m >40, f>50	35-41.9	94.70	86.55	82.93	94.44	87.93	76.32
	42-48.9	92.07	83.73	78.16	91.18	91.16	84.62
	49-55	91.78	85.11	76.53	95.32	92.59	85.71
LDL<100	35-41.9	51.40	33.61	35.00	26.76	23.42	25.00
	42-48.9	37.18	33.01	26.74	23.23	20.00	16.00
	49-55	28.95	18.45	15.46	26.17	15.79	24.39
LDL<130	35-41.9	84.42	70.59	75.61	65.28	56.03	47.37
	42-48.9	68.80	60.76	66.67	53.92	41.50	40.38
	49-55	55.92	48.94	49.98	53.27	45.92	47.62
RR<130/85	35-41.9	75.39	57.98	53.66	55.56	45.55	31.58
	42-48.9	71.61	63.64	37.93	53.92	42.22	25
	49-55	59.87	50.21	35.71	42.99	30.37	30.95
TG<150	35-41.9	95.33	81.51	85.37	84.72	58.62	34.21
	42-48.9	95.40	81.82	73.56	77.45	61.90	51.92
	49-55	92.43	81.28	66.33	82.24	62.22	48.86
HDL>60 and LDL<100 and RR<130/85	35-41.9	35.20	10.08	19.51	11.11	4.31	0.00
	42-48.9	24.04	12.92	3.45	9.80	4.76	0.00
	49-55	15.46	9.79	2.04	4.67	2.22	4.76
HDL m>40, k>50 and LDL<130 and RR<130/85 and TG< 150	35-41.9	59.19	31.09	34.15	36.11	20.69	5.26
	42-48.9	45.78	26.79	12.64	24.51	10.88	9.62
	49-55	30.59	22.13	11.22	19.63	7.41	14.29

of overweight subjects between 35 and 55 years of age. This is in contrast with the group of women, in whom the percentage of subjects with BMI < 25 fell by about 30% and the percentage of subjects with BMI > 35 doubled (see Table 5).

Authors of publications commonly extend age limits of the analysed populations and treat both genders together within a single age group, which in our view obscures the revealed differences. MacDonald et al. evaluated the Canadian population and found similar relationships to ours, except for being less pronounced [29]. Similar findings concerning blood pressure, but slightly less pronounced, for total cholesterol in relation to BMI were reported by A. H. Mokdad et al. [21] In these studies, however, no breakdown by gender was provided or the study populations were characterised by wider age ranges.

The second part of the analysis, with consideration to the division into groups by BMI and age, enabled us to perform an evaluation of the mean values of the assessed parameters within genders. Most of the mean values of the assessed parameters in the group of women depended on age and body mass, while in the group of men, this relationship was more pronounced for BMI than for age. We found a distinct trend towards the most favourable mean values in the youngest and the lightest group (see Table 3). This trend was particularly evident in the group of women.

This finding, along with the previously mentioned difference between the mean values in the group of men and in the group of women, leads to questions about the prevalence of these risk factors in the population or, rather, how many people are devoid of these factors in subgroups so delimited.

Table 5. Percentage of persons in groups defined by BMI age and gender.

	Female			Male		
Age	BMI<25	25-29.9	BMI≥30	BMI<25	25-29.9	BMI≥30
35-41.9	66.74	24.74	8.52	31.86	51.33	16.81
42-48.9	56.91	30.42	12.66	33.89	48.84	17.28
49-55	47.72	36.89	15.38	37.68	47.54	14.79
35-55	56.29	31.19	12.52	34.65	49.08	16.28

According to the data presented in Table 4, much fewer men belong to the subgroups described by positive outcomes and membership of these subgroups depends exclusively on BMI, especially for HDL-cholesterol and blood pressure. No such relationship is evident in the case of subjects with LDL-cholesterol values of <100 mg/dl. It becomes apparent for subjects with LDL <130 mg/dl.

Observations come to mind when one compares the less and more rigorously defined lipid criteria (Table 4). The optimal levels of the individual lipid parameters are achieved by less than 50% of men, independently of the analysed parameter. Only after the adoption of a cut-off value of 40 mg/dl for HDL-cholesterol in men, 75-95% of the population begins to satisfy this criterion. Simultaneous satisfaction of 4 criteria (normal blood pressure and normal HDL-cholesterol, LDL-cholesterol and triglyceride levels) in the group of men, except for the youngest and lightest subgroup (35 to 41.9 years of age, BMI < 25), is observed in less than 25% of the study population. In women, the situation is better and in the most favourable group of women, namely those aged 35 to 41.9 years and with BMI < 25, this percentage is 59.19%. Of note is the fact that with increasing BMI, independently of age, the percentage of men with favourable HDL-cholesterol values dramatically decreases. This decrease is much more pronounced in the subgroups with higher BMI (seven-fold). These relationships suggest the necessity to remember not to evaluate the two genders together in population studies, without taking into account the age of women, because the results may then be different. Although as Roher et al. demonstrated, obesity is a risk factor for hypertension, we did not observe this association in the group of women aged from 35 to 41.9 years [30].

Our material demonstrates a very strong association between body mass, especially in men, and the values of lipid parameters. In middle-aged women, the relationship is more pronounced with regard to age, than body mass. Women from the youngest age group with BMI ≥ 30 had either more favourable or comparable values of lipid parameters than women over the age of 48 with normal weight. Recently published data originating from an extensive meta-analysis indicate a possible relationship between increased levels of TG and a higher risk of stroke in women [31]. It is notable that in the studied population, a share of women with increased TG concentration grows as BMI rises, while in the subgroup of obese women, this share also grows as age progresses. In the analysed group, a percentage of obese women also increase with age, which is particularly worrying in light of the above-mentioned meta-analysis. These two observations imply that this section of female population (aged ≥49, BMI≥30) should be the target of intensive preventive measures, which could reduce the risk of ischemic stroke.

We have demonstrated that evaluation of the analysed lipid parameters and blood pressure should be performed with consideration to gender and age. Otherwise conclusions may be obtained which are not satisfied by 75-95% of the population in a given age group. The estimation of the number of individuals described by positive health outcomes taking into consideration age and gender has significant practical considerations in the process of planning and proper targeting of preventive measures.

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