

The influence of the dietary habit on lipoprotein density in blood serum of men from Podlasie region

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Abstract

In the years 1987-1998 we conducted examined a group of 556 men three times. The nutritional status was evaluated as well as total cholesterol, HDL- and LDL-cholesterol and triglycerides concentration in blood serum and it allowed to evaluate the influence of nutrition on lipid status. The relationships between diet composition and lipid levels in the whole period of 9 years were evaluated using multidimensional linear regression analysis.

Among examined men, depending on the period of the study, values of serum total cholesterol ($C < 200$ mg/dk) favourable from the standpoint of arteriosclerosis prevention were noted in only 36-39%, with LDL-cholesterol below 130 mg/dl in 35-48%, HDL-cholesterol over 35 mg/dl in 87-94% and triglyceride levels below 200 mg/dl in 81-83% of the studied men. Among 6 basic nutrients of the diet, only plant fat was significantly influencing the concentration of triglycerides in blood serum – an increase of its consumption caused the decrease of triglyceride level. It has been proven that increasing amount of alcohol in the diet led to the increase of HDL-cholesterol in blood serum. Blood serum lipids were significantly influenced by BMI. Increased body mass index significantly influenced the concentration of total cholesterol, LDL-cholesterol and triglycerides in blood serum. In examined men with the increase of body mass index the HDL-cholesterol concentration was decreasing.

Summing it up-it has been shown that the diet of examined men directly and significantly influenced lipid concen-

tration in blood serum, and it also had an indirect influence on lipid concentration, through body mass regulation, which significantly influenced its concentration.

Key words: men, the dietary habit, cholesterol and its fractions, body mass index.

Introduction

Considering health problems according to the dietary habit arises from increasing part of diseases depending on improper nutrition among world population [1-3].

Increased mortality of middle-aged men in Poland [4,5], at the time of elevated vital activity, including work, was the reason which we examined health of men for. The aim of this study was to evaluate, in a prospective study, lipoprotein status in men, inhabitants of Podlasie region and refer it to the dietary habit.

Material and methods

The studies were conducted in the period 1987-1998 on a group of 556 working men, aged 25-54 at the beginning of the study. The study was conducted in three periods. The first screening was performed in the years 1987-1989, the second one in 1991-1993 and the third in 1996-1998. In all three periods 556 men (55,8%) were participating. To evaluate daily nutrition, a 24-hour consumption questionnaire was used, according to the method accepted by National Food and Nutrition Institute in Warsaw. To calculate the energy value of the diet and the content of nutrients and groups of products in it, tables containing energy and nutritive value of 190 products and meals from National Food and Nutrition Institute were used.

Ensuring during 9 years of study marking parameters of lipoprotein status with the same method was hard to do accord-

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ing to objective reasons. With the need of implementation a new method, each analysed parameter was marked in a particular number of serum samples, using new method and previously used method, and then new method was adjusted to get identical values using both methods. Additionally, in a statistical elaboration of the outcomes, they were identified by the year of their analysis.

The concentration of triglycerides was marked in blood serum in the first study by using a set of reagents Technicon Instruments Corporation Tarrytown. In 2nd and 3rd study Ciba-Corning Diagnostics Corp. set was used.

The concentration of total cholesterol in 1st and 2nd study was marked in blood serum by Libermann-Burchard method [6]. In 3rd study the concentration of total cholesterol in blood serum was marked by enzyme method, using reactants from Ciba Corning Diagnostics Corp.

Calculation of cholesterol HDL fraction in blood serum in 1st and 2nd study was done by precipitation method according to Lopes-Virelle [6,7]. In 3rd study, the concentration of cholesterol HDL fraction was calculated by enzyme method by using set of the firm Ciba-Corning Diagnostics Corp.

The concentration of cholesterol LDL fraction in blood serum was calculated using the Friedewald formula: cholesterol LDL = total cholesterol – cholesterol HDL – 0.2 x triglycerides.

In a statistical elaboration of outcomes a model proposed by van't Hof [8] was used, and it is based on the analysis "age-period-cohort" [9,10]. In this model there are three basic independent variables: age of the respondent, the period of study and the attachment to particular birth cohort. Beside these three independent variables there were also nutritional factors stated by authors [11,12], which affect the concentration of lipids in blood serum.

Multidimensional regression analysis was conducted by using SAS (Statistical Analysis System ver. 6.11) with the use of GENMOD procedure. Verification of statistical hypotheses was conducted with the level of significance $\alpha=0.05$.

Results

Accepted statistical method for the elaboration of outcomes allowed to include the fact of variability, arising from the use of different laboratory methods, because of which change of those methods did not influenced examined relations between nutrition and the total concentration of lipids. Because we couldn't exclude the influence of the changed method of calculation of lipids on obtained values, the conclusions about trends of time change were not drawn. However, the scope of appearing lipid concentrations may bring some information about mean values of their concentration in men in whole time of the study.

The values of mean concentration of particular lipoproteins in blood serum of men in next three studies are presented in *Tab. 1*.

Mean concentration of total cholesterol in blood serum in the period of 9 year observation of men was from 213.4 to 217.4 mg/dl. Values of cholesterol LDL fraction were unbalanced from 133.9 to 142.4 mg/dl, and changes of the concentra-

Table 1. The concentration of total cholesterol, cholesterol LDL and HDL fractions and triglycerides in blood of 556 men during next three studies in 9 years of observation

Examined lipoprotein		I study	II study	III study
Total cholesterol (TC) mg/dl	Mean	215.4	217.4	213.4
	SD	35.2	37.7	38.8
Cholesterol LDL fraction (LDL-C) mg/dl	Mean	138.8	142.4	133.9
	SD	33.6	34.8	34.7
Cholesterol HDL fraction (HDL-C) mg/dl	Mean	46.8	46.3	51.2
	SD	9.0	9.1	14.1
Triglycerides (TG) mg/dl	Mean	148.9	144.1	142.2
	SD	92.1	84.4	91.5

Table 2. The percent of men with normolipidemia and with different stages of hiperlipidemia among 556 men during 9 years of observation

Values of lipoproteins concentration		I study	II study	III study
Normolipidemia	TC < 200 mg/dl	n 184	163	199
	TG < 200 mg/dl	% 33.1	29.3	35.8
Hypercholesterolemia mild	200 mg/dl ≤ TC < 250 mg/dl	n 211	219	202
	TG < 200 mg/dl	% 37.9	39.4	36.3
Hypercholesterolemia severe	TC ≥ 250 mg/dl	n 64	68	59
	TG < 200 mg/dl	% 11.5	12.2	10.6
Hypercholesterolemia mixed	TC ≥ 200 mg/dl	n 80	89	76
	TG ≥ 200 mg/dl	% 14.4	16.0	13.7
Hipertriglyceridemia	TC < 200 mg/dl	n 17	17	20
	TG ≥ 200 mg/dl	% 3.1	3.1	3.6

TC – Total cholesterol, TG – triglycerides

tion of cholesterol HDL fraction from 46.3 to 51.2 mg/dl. The concentration of triglycerides during whole period of study was unbalanced from 144.1 to 148.9 mg/dl.

The percent of men with normolipidemia and with different stages of hiperlipidemia among 556 men in 9 years of observation is presented in *Tab. 2*.

During 9 years of observation normolipidemia (total cholesterol less than 200 mg/dl and the level of triglycerides less than 200 mg/dl) occurred only in 29.3%-35.8% of men (depending on the period of study).

The influence of the energy value of 24-hour consumption on the concentration of total cholesterol, cholesterol LDL and HDL fractions and triglycerides is presented in *Tab. 3*.

The energy value of the 24-hour consumption of men did not significantly influence the concentration of the total cholesterol, cholesterol LDL and HDL fractions and triglycerides in their blood serum.

The influence of nutrients on total cholesterol concentration, cholesterol LDL and HDL fractions and triglycerides is presented in *Tab. 4*.

Among 6 basic nutrients, only plant fat may influence total cholesterol concentration in blood, but because of $p=0.06$ it has to be well considered. None of analysed basic nutrients

Table 3. The influence of the energy value of 24-hour consumption on the concentration of total cholesterol, cholesterol LDL and HDL fractions and triglycerides during 9 years of observation of men

Dependent variables	Independent variables	Age $\Delta=1.0$ year	Differences between periods		Differences between cohorts		Diet energy (kcal) $\Delta=1.0$
			I-II	I-III	A-B	A-C	
Total cholesterol	Δ	0.85	-1.36	-9.62	2.31	5.34	-0.0005
	p	0.09	0.58	0.04	0.72	0.60	0.57
LDL-cholesterol	Δ	0.91	-0.14	-13.2	7.26	12.20	-0.001
	p	0.04	0.95	0.001	0.19	0.17	0.24
HDL-cholesterol	Δ	-0.23	0.50	6.83	-4.44	-2.60	0.0003
	p	0.04	0.43	0.00001	0.002	0.23	0.31
Triglycerides	Δ	0.91	-9.27	-14.78	1.94	-8.38	0.002
	p	0.45	0.09	0.19	0.90	0.73	0.39

Table 4. The influence of nutrients from the diet of men on total cholesterol concentration, cholesterol LDL and HDL fractions and triglycerides

Dependent variables (mg/dl)	Independent variables	Age $\Delta=1.0$ year	Differences between periods		Differences between cohorts		Animal protein $\Delta=1.0$ g	Plant protein $\Delta=1.0$ g	Animal fat $\Delta=1.0$ g	Plant fat $\Delta=1.0$ g	Total carbohydrates $\Delta=1.0$ g	Pure alcohol (96%) $\Delta=1.0$ g	Body Mass Index (BMI) $\Delta=1.0$ kg/m ²
			I-II	I-III	A-B	A-C							
Total cholesterol concentration	Δ	0.78	-1.62	-9.99	2.96	6.64				-9.09			1.43
	p	0.12	0.52	0.04	0.64	0.51				0.06			0.00001
LDL-cholesterol	Δ	0.90	-0.20	-13.61	7.33	12.60							0.76
	p	0.04	0.93	0.002	0.19	0.16							0.01
HDL-cholesterol	Δ	-0.18	0.63	7.03	-4.48	-3.04						0.11	-0.53
	p	0.07	0.31	0.00001	0.0008	0.14						0.00001	0.00001
Triglycerides	Δ	0.59	-10.72	-17.39	6.05	-1.33			0.07	-0.24			6.61
	p	0.60	0.05	0.11	0.69	0.95			0.07	0.02			0.00001

had significant influence on cholesterol LDL fraction in blood serum. In the case of cholesterol HDL fraction only alcohol has had a significant influence on its concentration. With growing amount of alcohol consumed there was an increase of cholesterol HDL fraction concentration. The amount of consumed by men plant fats has had a significant influence on triglycerides concentration in blood serum. Increasing consumption of plant fats was lowering the triglycerides concentration in blood serum of men.

The increase of body mass index (BMI) was significantly influencing the increase of total cholesterol, cholesterol LDL fraction and triglycerides in blood serum of men. In examined men with the increase of body mass index value, the concentration of cholesterol HDL fraction in blood serum was decreasing.

Discussion

In our own study, the percentage of men with needed, from the standpoint of arteriosclerosis prevention, concentrations

of particular lipids were small and they were closing to values presented in other national essays. In Pol-MONICA [13] study, an evaluation of lipids of men from Warsaw, aged identically as men during our 3rd study in the years 1996-98, was conducted in 1984. The study of Pol-MONICA presents the occurrence of normolipemia in 31% of examined men, while in our study it was present in 36% of men (the evaluation of normolipidemia according to the same criteria). Also concentrations of total cholesterol and its LDL and HDL fractions in both studies were very similar. The differences were observed in case of triglycerides, that is, in corresponding age groups in our study mean concentration was 142.2 mg/dl, and in Pol-MONICA study – 171.6 mg/dl [14].

Performed research showed, that only plant fat consumption has had a significant influence on triglycerides concentration. With the increase of consumption of plant fats, the concentration of triglycerides in blood serum of examined men was decreasing. Several papers and essays show the influence of unsaturated fatty acids on lipids, particularly the decrease of triglycerides in blood serum with an increased consumption of those fatty acids [15,16]. However, publications sometimes

present statements, in which for example, after examination of 2900 of United States of America habitants of different sex, age and race, the influence of total fats consumption, saturated and unsaturated fats and carbohydrates on the concentration of cholesterol LDL and HDL fractions and triglycerides was not observed [17]. In DRECAN-Study, in observations including habitants of united Germany in the years 1990-91, was not observed, that changes of the diet in a consequence of unity have the influence on the concentration of lipoproteins in blood serum [18]. A few population studies conducted in Poland conclude also, that evaluations of nutrition used nowadays, allowed to find the influence of only few nutritional factors on lipoproteins concentration [19,20]. In men examined in Pol-MONICA study [20], nutritional factors were responsible only for 0.9-2.4% of lipoproteins concentration variance, however, authors do not show the influence of diet composition on the concentration of total cholesterol and its LDL and HDL fractions.

In our study we demonstrated, that increasing alcohol consumption caused the increase of the concentration of cholesterol HDL fraction in blood serum. Among other papers referring to nutrition, conducted in our country, the influence of alcohol consumption on the concentration of lipoproteins was evaluated in the Pol-MONICA study, showing the relationship between the features [21]. In the studies on Finland, Italy and the Netherlands habitants, which evaluated the influence of alcohol consumption on the concentration of lipoproteins it was ascertained, that increasing alcohol consumption was increasing cholesterol HDL fraction, but it has not had an influence on total cholesterol concentration [22]. However, based on full knowledge in this field of study, including other disadvantageous results of alcohol consumption, there is no reason, also according to World Health Organization experts, to propagate moderate alcohol consumption [23].

The examination of men showed, that with the increase of body mass index (BMI) the concentration of triglycerides, total cholesterol and its fraction LDL was increasing, and the concentration of cholesterol HDL fraction in blood serum was decreasing. The influence of body mass or its measurements, like overweight and obesity, and particularly cholesterol HDL fraction, were described relatively long ago [22,24,25]. In men examined in selected european countries, the increase of BMI index has had a significant influence on the increase of total cholesterol and decrease of cholesterol HDL fraction [22]. The body mass index of men examined in the 70s in a Coronary Prevention Program, was positively correlated with triglycerides and additionally with total cholesterol only in a group aged 20-39 years and negatively with cholesterol HDL fraction [26]. Also in subsequent Pol-MONICA studies [27], the increase of total cholesterol and its LDL fraction and triglycerides and the decrease of cholesterol HDL fraction with increasing BMI value were proven. The frequency of abnormal cholesterol and its fractions and triglycerides concentrations occurrence was higher among obese people than among people with correct body mass index [28].

Conclusions

The evaluation of lipoprotein density in blood serum showed great threat of arteriosclerosis development in a group of men, inhabitants of Podlasie region, because during 9 years of observation in 64-71% of men improper values of lipoprotein values were observed. The study shows that this threat may be beneficially modified by the increase of plant fat consumption and the decrease of the body mass index.

References

1. Garrow JS. Obesity. In: Garrow JS, James WPT, Ralph A, editors. Human nutrition and dietetics. Edinburgh Churchill Livingstone; 2000, 527-45.
2. Dieta, żywienie i profilaktyka chorób przewlekłych, Raport grupy badawczej Światowej Organizacji Zdrowia. Seria Raportów Nr 797, Światowa Organizacja Zdrowia, Genewa, 1990. Żyw Człow Metab, 1991; 18: 208-36.
3. Żywienie a rozwój – ocena globalna. Materiały z Międzynarodowej Konferencji Żywnościowej. Rzym 1992, Warszawa, Seria Przekładów Instytutu Żywności i Żywnienia; 1995.
4. Wojtyński B, Chańska M, Goryński P, editors. Sytuacja zdrowotna ludności Polski w 1996 roku. Warszawa, Państwowy Zakład Higieny; 1998.
5. Narodowy program zdrowia 1996-2005. Warszawa, Ministerstwo Zdrowia i Opieki Zdrowotnej; 1996.
6. Richterich R. Chemia kliniczna. Warszawa, PZWL; 1971.
7. Lopes-Virella MF, Stone P, Ellis S, Colwell JA. Cholesterol determination in high-density lipoproteins separated by three different methods. Clin Chem, 1977; 23: 882-4.
8. van't Hof MA, Burema J. Assessment of bias in the SENECA study. Eur J Clin Nutr, 1996; 50: Suppl. 2, S4-S8.
9. Holford TR. An alternative approach to statistical age-period-cohort analysis. J Chronic Dis, 1985; 38: 831-6.
10. Kupper LL, Janis JM, Kormous A, Greenberg BG. Variance and Dissent. Statistical age-period-cohort analysis: a review and critique. J Chronic Dis, 1985; 38: 811-30.
11. Kromhout D. Body weight, diet, and serum cholesterol in 871 middle-aged men during 10 years of follow-up (the Zutphen Study). Am J Clin Nutr, 1983; 38: 591-8.
12. Williams PT, Krauss RM, Wood PD, Albers JJ, Dreon D, Ellsworth N. Associations of diet and alcohol intake with high-density lipoprotein subclasses. Metabolism, 1985; 34: 524-30.
13. Rywik S, Broda G, Piotrowski W, Wągrowka H, Polakowska M, Pardo B. Epidemiologia chorób układu krążenia – Program Pol-MONICA Warszawa. Kard Pol, 1996; 44: suppl. II, 7-35.
14. Rywik S. ed. Program Pol-MONICA Warszawa. Kompleksowa ocena stanu zdrowia ludności Warszawy i jego zmian w latach 1984-1990. Cz. I. Podstawowe wyniki dwóch badań przekrojowych przeprowadzonych w latach 1984 i 1988 w populacji prawobrzeżnej Warszawy. Warszawa, Prace Instytutu Kardiologii 42; 1993.
15. Harris WS, Connor WE, McMurry MP. The comparative reductions of the plasma lipids and lipoproteins by dietary polyunsaturated fats: salmon oil versus vegetable oils. Metabolism, 1983; 32: 179-84.
16. Kolanowski W, Świdorski F. Wielonienasycone kwasy tłuszczowe z grupy n-3 (n-3 PUFA). Korzystne działanie zdrowotne, zalecenia spożycia, wzbogacanie żywności. Żyw Człow Metab, 1997; 24: 49-63.
17. Ludwig DS, Pereira MA, Kroenke CH, Hilner JE, van Horn L, Slattery ML, Jacobs DR. Dietary fiber, weight gain, and cardiovascular disease risk factors in young adults. JAMA, 1999; 282: 1539-46.
18. Wahrburg U, Martin H, Bergmann S, Schulte H, Jaross W, Assmann G. Dietary habits in Eastern Germany. Changes due to German reunification and their relations to serum lipids: results of the DRECAN-Study. Nutr Metab Cardiovasc Dis, 1995; 5: 201-10.
19. Narojek L, Malecka Z, Szostak WB, Kulesza W, Chotkowska E, Rywik S. Charakterystyka sposobu żywienia mężczyzn w wieku 40-59 lat, zatrudnionych w wybranych warszawskich zakładach pracy. Cz. II. Jakość żywienia a poziom cholesterolu i trójglicerydów w surowicy krwi. Rocznik Państw Zakł Hig, 1980; 31: 9-15.
20. Pardo B, Piotrowski W. Analysis of the relationship between age, body mass, smoking, nutritional habits and plasma lipids in POL-MONICA Warsaw population. Żyw Człow Metab, 1992; 19: 3-10.

21. Waškiewicz A, Sygnowska E, Piotrowski W. Związek między spożywaniem alkoholu a umieralnością spowodowaną chorobami układu krążenia wśród mężczyzn objętych programem Pol-MONICA Warszawa. *Czynniki Ryzyka*, 1996; 4: 63-8.
22. Kromhout D, Nissinen A, Menotti A, Bloemberg B, Pekkanen J, Giampaoli S. Total and HDL cholesterol and their correlates in elderly men in Finland, Italy, and the Netherlands. *Am J Epidemiol*, 1990; 131: 855-63.
23. Press Release WHO: Umiarkowane picie. Poważne ostrzeżenie specjalistów WHO. *Czynniki Ryzyka*, 1995; 2: 62-3.
24. Heiss G, Johnson NJ, Reiland S, Davis CE, Tyroler HA. The epidemiology of plasma high-density lipoprotein cholesterol levels. The Lipid Research Clinics program prevalence study. *Circulation*, 1980; 62: suppl, 4, 116-36.
25. Must A, Spadano J, Coakley EH, Field A, Colditz G, Dietz WH. The disease burden associated with overweight and obesity. *JAMA*, 1999; 282: 1523-9.
26. Chotkowska E, Charzewska J. Correlations between body mass index and serum concentrations of triglycerides, total cholesterol, high density lipoprotein cholesterol and glucose in a population of men aged 20 to 59 years. *Żyw Człow*, 1982; 9: 161-7.
27. Pająk A, Sznajd J, Jamska B, Czarnecka H, Rostworowski W, Żarnecki A, Broda G, Rywik S, Chodkowska E, Bednarska M, Kuriata P, Kupść W. Stężenie lipidów i lipoprotein osocza w populacji rolniczej i przemysłowej Polski zależnie od czynników ryzyka choroby niedokrwiennej serca. *Przeg Lek*, 1990; 47: 454-8.
28. Rywik S, Wągrowka H, Piotrowski W, Broda G. Epidemiologia otyłości jako czynnika ryzyka chorób układu krążenia. *Pol Tyg Lek*, 1995; 50: suppl, 1, 64-7.