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ASSESSMENT OF ATHEROGENICITY OF STUDENTS DAILY DIETS OF WROCŁAW MEDICAL UNIVERSITY

OCENA ATEROGENNOŚCI CAŁODZIENNYCH RACJI POKARMOWYCH STUDENTÓW AKADEMII MEDYCZNEJ WE WROCŁAWIU

Bożena Regulska-Ilow[1], Rafał Ilow[2], Katarzyna Rojowska[2], Anna Kawicka[1], Agnieszka Salomon[1], Dorota Różańska[1]

[1]Department of Dietetics, Wrocław Medical University, Wrocław
[2]Department of Food Science and Dietetics, Wrocław Medical University, Wrocław

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STRESZCZENIE

Wprowadzenie. Wyniki badań naukowych wskazują, iż nadmierne spożycie produktów będących źródłem nasyconych kwasów tłuszczowych (NKT) i cholesterolu oraz zaburzone proporcje w spożyciu jedno- (JNKT) i wielonienasyconych (WNKT) kwasów tłuszczowych wpływają na rozwój zmian miażdżycowych już od wczesnych lat życia.
Cel. Oceniono aterogenność diet studenckich przez oszacowanie w nich zawartości poszczególnych kwasów tłuszczowych, ich wzajemnych proporcji oraz cholesterolu.
Materiały i metody. Grupę badaną stanowiło 127 studentów (kobiety-100, mężczyźni-27) Akademii Medycznej we Wrocławiu. Sposób żywienia w badanej grupie oceniono metodą bieżącego notowania jadłospisów z trzech dni, w tym jednego dnia weekendowego, przy użyciu ankiety żywieniowej.
Wyniki. Udział energii z nasyconych kwasów tłuszczowych (NKT) przekraczał dozwolone 10% całodziennego zapotrzebowania energetycznego i średnio w dietach studentek i studentów wynosił 14,3% i 15,6%. Średni odsetek energii pochodzącej z jednonienasyconych kwasów tłuszczowych (JNKT) w dietach studentek wynosił 12,8%, a studentów 15,3%, przy wartościach zalecanych ≥14% dobowego zapotrzebowania energetycznego. Zawartość cholesterolu w dietach badanych kobiet wynosiła średnio 278,7 mg/dobę, a mężczyzn 428,1 mg/dobę, przy wartości dopuszczalnej 300 mg/dobę. Aterogenność oceniona współczynnikiem *Keys'a* wynosiła w dietach studentek średnio 49,2 przy zalecanych wartościach 30,1–35,5, a w dietach studentów 52,3 przy zalecanych wartościach 28,4-33,8. Aterogenność oceniona współczynnikiem P/S w obu grupach wynosiła 0,4, przy wartościach zalecanych ≥ 1. Udział energii z wielonienasyconych kwasów tłuszczowych (WNKT) przy dozwolonym zakresie 6-10%, w średniej diecie studentek wynosił 5,3%, a studentów 6,0%. Suma kwasów EPA i DHA w dietach studentek wynosiła 0,1 g/dobę, a stosunek WNKT n-6/n-3 wynosił 5,8:1 (zalecany 4:1). Suma EPA i DHA w dietach studentów wynosiła 0,2 g/dobę, stosunek kwasów WNKT n-6/n-3 wynosił 6,1:1.
Wnioski. Wykazano, iż badane diety mogą sprzyjać rozwojowi zmian miażdżycowych.

ABSTRACT

Background. Results of the research indicate that excessive consumption of products that are a rich source of the saturated fatty acids (SFA) and cholesterol, and disturbed balance in the monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) intake could affect the development of atherosclerotic lesions since the childhood.
Objective. The aim of the study was to evaluate the atherogenicity of the students diets, based on the content of various fatty acids (FA), their relative proportions, and the content of cholesterol.
Material and methods. The study group included 127 students (female-100, male-27) of Wrocław Medical University. Dietary habits in the study group were evaluated by the method of the three-day diet record including one weekend day. In total 381 dietary interviews: 300 from female and 81 from male were analyzed.
Results. The percentage of energy from SFA was higher than recommended 10%. The average percentage of energy from SFA in the diets of male and female was 14.3% and 15.6%. The average percentage of energy from MUFA in the diets of female and male was respectively 12.8% and 15.3%. The recommended average percentage of energy from MUFA is ≥ 14% of daily energy requirements. The daily intake of cholesterol should be less than 300 mg/day. The average content of

Corresponding author: Bożena Regulska-Ilow, Department of Dietetics, Wrocław Medical University, 51-616 Wrocław, Parkowa 34, Poland, phone +48 71 348 25 70,
e-mail: bozena.regulska-ilow@am.wroc.pl

cholesterol in the diets of female was 278.7 mg/day, and male 428.1 mg/day. The Keys atherogenic score assessed in the diets of female was on average 49.2 with recommended values of 30.1-35.5, and 52.3 in the diets of male at the recommended values of 28.4-33.8. Atherogenicity estimated by P/S ratio in both students groups was 0.4 at the recommended values of ≥ 1. The recommended daily percentage of energy from PUFA is 6-10%. The percentage of energy from PUFA in the average diet of female was 5.3%, and 6.0% in the male diets. The sum of EPA and DHA in the female diets was average 0.1 g/day, and the n-6/n-3 PUFA ratio was 5.8:1 (recommended 4:1). The sum of EPA and DHA in the male diets was 0.2 g/day, and the n-6/n-3 PUFA ratio was 6.1:1.

Conclusions. It was shown that studied students diets may promote the development of atherosclerotic lesions.

INTRODUCTION

Cardiovascular disease (CVD) occurrence is a leading cause of premature mortality in developed countries, including Poland. The results of basic scientific research indicate that both type of fatty acids (FA) and amount of dietary FA has a decisive influence on the formation and conduct of athero-thrombotic disease [17, 24, 26]. The excessive consumption of products that are sources of saturated fatty acids (SFA) and cholesterol, and disturbed balance in the monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) intake would affect the progress of atherosclerotic lesions since the childhood [19].

Polyunsaturated omega-3 fatty acids such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) play a particular role in preventing the CVD, by exerting positive effect on the lipid profile by reducing serum triglycerides [11]. *Omega*-3 fatty acids may also have a multi-factorial mode of action including anti-inflammatory effects, antiarrhythmic effects, antithrombotic effects, lowering blood pressure effects and have a beneficial effect on impaired homeostasis [16, 18]. The authors of many randomized clinical trials have shown that diet supplementation with *omega*-3 EPA and DHA, had an impact on the reduction of mortality due to CVD incidents [22, 39, 44].

According to the present guidelines of Polish Forum for Prevention of Cardiovascular Disease [12], dietary n-6/n-3 PUFA ratio in the diet should be below than 4/1. Western diets are deficient in *omega*-3 fatty acids and the n-6/n-3 ratio is considerably impaired and amounts 15-16.7:1 [30]. In the diet of Poles the n-6/n-3 ratio ranges from 9/1 to 11/1, which is caused by excessive intake of *omega*-6 PUFA [13, 35]. A rich sources of linoleic acid n-6 (LA-C18:2) are: sunflower oil, soybean oil, corn oil, safflower oil, grapeseed oil, wheat germ oil and margarine which are made from them [15]. Preventative importance of low n-6/n-3 PUFA ratio arises from a difference in the physiological effect of eicosanoids formed from these acids in the organism [3, 10]. The main sources of *omega*-3 PUFA, which is representative by *alpha*-linolenic acid (ALA-C18:3) are vegetable oils such as: flaxseed oil (also known as linseed oil), rapeseed oil, soybean oil, walnuts, pumpkin seeds and flax seeds [11]. The recommended amounts of EPA and DHA can be provided by consumption of a marine fish (or fish oil) such as: herring, mackerel, sprat, halibut, salmon, tuna, sardines and food fortification with these acids or food supplements [15].

In view of the varied influence FA on lipid profile, the assessment of their content and relative proportions, and also the evaluation of the diet atherogenicity is a necessary step in both for the analysis and arranging properly balanced menus.

The aim of the present study was to evaluate the atherogenicity of students diets, from the perspective of the CVD prevention.

MATERIALS AND METHODS

Subjects

The study group included 127 students (female-100, male-27) of Wroclaw Medical University. Average age among male and female was respectively 22 ± 0.9 and 23 ± 1.2 years. Average height, weight and BMI in the group of female amounted respectively to 166 ± 6.1 cm, 56 ± 8.8 kg and 20 ± 2.5 kg/m^2 and in the group of male 180 ± 4.6 cm, 74 ± 9.7 kg and 23 ± 2.6 kg/m^2. Dietary habits in the study group were evaluated by the method of the three-day diet record including one weekend day. In total, 381 dietary interviews: 300 from female and 81 from male were analyzed. During the interviews particularly carefully nutritional type and frequency of consumption of products with a significant fat content, such as: dairy products, oil, fat spreads, fish, nuts and seeds were established. The weight of the consumed products, were determined by the "Album of photographs of food products and dishes" [38]. Analyses of the diets were performed using the "Food Processor" SQL version 9.8.1's ESHA Research (USA), having Polish database from the "Food Composition Tables" [15].

Measures

The average daily energy intake and the average content of total protein, total carbohydrates, dietary fiber, total fat, selected fatty acids and total SFA (C4:0, C6:0, C8:0, C10:0, C12:0, C14:0 , C15:0, C16:0, C17:0, C18:0, C20:0), MUFA (C14:1, C15:1, C16:1, C17:1, C18:1, C20:1, C22:1) *omega*-6 PUFA (C18:2, C20:4), and *omega*-3 PUFA (C18:3, C20:5, C22:5, C22:6) in the diets were computed. The average quantity of cholesterol in the diets of female and male was also calculated. The results of up to ± 10% compared to the recommendations, with the exception of average energy intake, have not been questioned.

Keys score was set in order to determine diet atherogenicity. The recommended daily energy intake was assumed in the age category with the moderate physical activity (female - 2293 kcal/day, male - 3200 kcal/day). According to the National Food and Nutrition Institute recommendations for consumption of SFA should provide < 10% daily energy intake and PUFA should provide 6 to 10% of daily energy intake [9]. Appointed reference Keys score was compared with the estimated for the study population. Assuming that the daily intake of energy from SFA was equal to 10% and the daily intake of energy from PUFA was equal to 6%, the Keys score was 35.5 in the group of female and 33.8 in the group of male. While assuming that the daily energy intake of PUFA was equal to 10%, this ratio was respectively 30.1 for female and 28.4 for male. The Keys score was calculated as follows:

$$\text{Keys score} = 1.35 * (2 * \text{SFA} - \text{PUFA}) + 1.5 * \sqrt{(\text{diet chol.}/1000\text{ kcal})}$$

SFA - % of energy intake from saturated fatty acids
PUFA - % of energy intake from polyunsaturated fatty acids
diet chol. – cholesterol from diet [mg]

P/S ratio determines the content of PUFA compared to SFA and also specify the diet atherogenicity. On the assumption that PUFA represent 6% of daily energy intake, and SFA 10%, the ratio P/S is 0,6 (minimum value). However, with an increase of PUFA to 10% daily energy intake this ratio rises to 1.0 (optimal value).

Keys score and P/S ratio do not include the content of MUFA in the diet, which possess hypocholesterolemic and anti-inflammatory action by inhibition synthesis of some inflammatory cytokines, blocking the activity of natural killers cells (NK) and reducing the expression of adhesion molecules on human monocytes [4]. According to the National Food and Nutrition Institute recommended MUFA intake should be a difference between the amount of total fat and the sum of content SFA and PUFA in the diet [9]. The experts from the Polish Forum for Prevention of Cardiovascular Diseases consider that intake of MUFA amounting to 20% daily energy intake has a beneficial effects [11]. Taking into consideration these recommendations the optimal level of MUFA intake was set at ≥14% of the daily energy intake.

The correlations between the content of MUFA and the content of other selected nutrients and energy value of diets were analyzed. The study population was divided into 2 groups. Group I, which diet contained <14% of energy from MUFA and group II, which diet contained ≥14% of energy from MUFA. In this manner the grouping variable, used for analysis nutritional variables, was obtained.

The ratio of n-6/n-3 PUFA in the studied diets was calculated by using a model: n-6 PUFA (C18:2 + C20:4)/n-3 PUFA (C18:3 + C20:5 + C22:6). According to the Polish Cardiac Society recommendations of n-6/n-3 PUFA ratio should be at most 4:1, preferably 1:1 [12].

Statistical analysis

Statistical analyses were performed using the "Statistica PL 10.0" StatSoft. Inc. USA. Significant differences between linear variables were evaluated using tests: t-*Student* and U *Mann Whitney* test. All differences in the reported values as $p<0.05$ were considered as statistically significant.

RESULTS AND DISCUSSION

Table 1 presents the average values of energy intake of the daily food rations and average content of total protein, total carbohydrates, fiber, total fat, cholesterol and selected fatty acids in the study diets.

Average energy intake in the diets of female was 1818.6 kcal and 2731.9 kcal in the diets of male. The daily recommended energy intake for female, aged 19-30 years with moderate physical activity, is in the range of 2000 to 2400 kcal, whereas for male 3100-3600 kcal. The energy intake by the students should be regarded as too low relative to current recommendations of daily energy intake. Average daily energy intake among students from Białystok amounted to 1473.3 kcal [34] and was lower than that obtained in the present study. In the studies assessing the nutrition of university students from Lublin [23], Warsaw [7] and Wrocław [8] also have been shown that diets of female students did not provide sufficient amount of energy intake in daily food rations compared with the recommendation, while in the case of male students the diets covered the recommended daily dietary energy intake. However, the average daily energy intake in the diets of female in the present study was higher than the results obtained in the National Multicenter Health Survey in Poland Project WOBASZ [2], where the average energy intake, for the group aged 20-34 years, was 1777 kcal/day for female and 2862 kcal/day for male.

Average protein intake in the female diets was 62.3 g/day and in the diets of male 102.7 g/day. The protein

Table 1. Comparison of the value of average energy intake and contents of selected nutrients in the daily food rations of the respondents depending on sex

Variable	Unit	Female (F) n=100	Male (M) n=27	F vs M p
		X ± SD	*X ± SD*	
Energy	kcal	1818.6 ± 369.2	2731.9 ± 842.8	<0.0001
Total proteins	g	62.3 ± 13.8	102.1 ± 33.5	<0.0001
Energy from proteins	%	13.8 ± 2.1	15.2 ± 3.0	0.0206
Total carbohydrates	g	244.9 ± 56.9	312.6 ± 92.7	0.0002
Energy from carbohydrates	%	49.7 ± 6.4	42.6 ± 7.2	<0.0001
Dietary fiber	g	19.6 ± 7.2	24.4 ± 10.8	0.0131
Total fats	g	71.6 ± 21.0	122.6 ± 50.1	<0.0001
Energy from fats	%	35.2 ± 6.0	39.8 ± 6.9	0.0047
Cholesterol	mg	278.7 ± 153.2	428.1 ± 226.0	<0.0001
Cholesterol/1000 kcal	mg	131.2 ± 44.8	152.6 ± 58.3	>0.05
Keys score		49.2 ± 11.5	52.3 ± 9.6	>0.05
P/S ratio		0.4 ± 0.2	0.4 ± 0.1	>0.05
Saturated fatty acids (SFA)				
Σ SFA	g	29.1 ± 10.2	48.1 ± 21.7	<0.0001
Energy from SFA	%	14.3 ± 3.5	15.6 ± 3.1	>0.05
Butyric acid (C4:0)	g	0.5 ± 0.2	0.7 ± 0.3	0.0019
Caproic acid (C6:0)	g	0.3 ± 0.1	0.5 ± 0.3	0.0015
Caprylic acid (C8:0)	g	0.3 ± 0.1	0.4 ± 0.2	<0.0001
Capric acid (C10:0)	g	0.7 ± 0.3	1.0 ± 0.5	0.0002
Lauric acid (C12:0)	g	1.1 ± 0.5	1.6 ± 0.8	0.0019
Myristic acid (C14:0)	g	3.5 ± 1.6	5.6 ± 3.1	<0.0001
Pentadecanoic acid (C15:0)	g	0.4 ± 0.2	0.7 ± 0.4	<0.0001
Palmitic acid (C16:0)	g	15.2 ± 5.4	25.9 ± 11.8	<0.0001
Heptadecanoic acid (C17:0)	g	0.3 ± 0.1	0.5 ± 0.2	<0.0001
Stearic acid (C18: 0)	g	6.7 ± 2.4	10.9 ± 4.7	<0.0001
Arachidic acid (C20:0)	g	0.1 ± 0.1	0.2 ± 0.1	<0.0001
Monounsaturated fatty acids (MUFA)				
Σ MUFA	g	26.1 ± 8.2	47.2 ± 20.5	<0.0001
Energy from MUFA	%	12.8 ± 2.6	15.3 ± 3.2	0.0007
Myristoleic acid (C14:1)	g	0.3 ± 0.2	0.5 ± 0.3	0.0002
Pentadecenoic acid (C15:1)	g	0.1 ± 0.1	0.1 ± 0.1	0.0140
Palmitooleic (C16:1)	g	1.2 ± 0.5	2.5 ± 1.2	<0.0001
Margaroleic acid (C17:1)	g	0.2 ± 0.1	0.3 ± 0.1	0.0009
Oleic acid (C18:1) n-9	g	23.8 ± 7.5	42.8 ± 18.7	<0.0001
Eicosenoic acid (C20:1)	g	0.3 ± 0.2	0.6 ± 0.3	<0.0001
Erucic acid (C22:1)	g	0.2 ± 0.3	0.4 ± 0.4	0.0014
Polyunsaturated fatty acids (PUFA)				
Σ PUFA	g	10.7 ± 4.6	18.3 ± 6.9	<0.0001
Energy from PUFA	%	5.3 ± 1.8	6.0 ± 1.5	0.0152
Linoleic acid (C18:2) n-6	g	8.9 ± 4.0	15.1 ± 6.2	<0.0001
α-linolenic acid (C18:3) n-3	g	1.5 ± 0.7	2.3 ± 1.0	<0.0001
Arachidonic acid (C20:4) n-6	g	0.1 ± 0.1	0.2 ± 0.1	<0.0001
(C18:2) + (C18:3)	g	10.4 ± 4.5	17.4 ± 6.9	<0.0001
Eicosapentaenoic acid –EPA (C20:5) n-3	g	0.05 ± 0.13	0.05 ± 0.15	>0.05
Docosapentaenoic acid -DPA (C22:5) n-3	g	0.01 ± 0.03	0.01 ± 0.03	>0.05
Docosahexaenoic acid -DHA (C22:6) n-3	g	0.07 ± 0.18	0.10 ± 0.24	>0.05
EPA + DHA	g	0.1 ± 0.3	0.2 ± 0.4	>0.05
n-6/n-3 ratio		5.8 : 1	6.1:1	>0.05

*X ± SD- average ± standard deviation; p>0.05= statistically insignificant; p<0.05= statistically significant; SFA- saturated fatty acids; MUFA- monounsaturated fatty acids; PUFA- polyunsaturated fatty acids; Σ- sum; P/S- polyunsaturated fatty acids/saturated fatty acids intake in female diets fulfilled the recommendations, expressed as estimated average requirement (EAR) for the Polish population. However, in the diets of male this value exceeded the recommendations. Similar results were obtained in the study of female students from Białystok [34] where the average protein intake carries out the EAR. The percentage of energy from protein in the diets of studied male and female was respectively 13.8% and 15.2% and filled the recommendations [9].

Average carbohydrate intake in the female diets was 244.9 g/day and in the male diets 312.6 g/day. These values did not fulfilled the recommendations of dietary carbohydrates intake at the EAR level for the Polish population, both in the diets of female and male [9]. In the study of *Marzec* et al [23] the carbohydrate content in the diets of female was 249 g/day and in the diets of male 378 g/day. *Ilow* [8] assessed that the average content of carbohydrates in the diets of female was 264.3 g/day, and in the male diets 380.1 g/day. The percentage of energy from carbohydrates in the female students diets amounted to 49.7%, and in the diets of male students 42.6%, which was too low in relation to recommendations [9].

The appropriate dietary fiber intake is correlated with a low prevalence of CVD [42]. Following the recommendations intake of dietary fiber should be in the range of 20-40 g/person/day [9]. In the studied diets the average content of dietary fiber was at the lower level of recommendations and amounted respectively to 19.6 g/day in female and 24.4 g/day in male. According to the studies of *Przysławski* et al [27] and *Szczepańska* et al [36], diets of female and male students did not provide the recommended amount of fiber. The average content of dietary fiber in the diets of female was respectively 15.4 g/day and 16.1 g/day, and in the diets of male respectively 17.9 g/day and 15.5 g/day [27, 36]. Conversely different results were presented by *Wyka* et al [43], where was the proper average content of dietary fiber in the diets of male 22.4 g/day but too low in the diets of female 15.7 g/day.

The average intake of total fat in female diets amounted to 71.6 g/day and in male 122.6 g/day. Daily recommendations for fat intake in the diet include age, sex, body weight and physical activity [9]. This results are consistent with the norms of daily fat intake in the female diets while in the male diets the content of fat was exceeded in comparison to the norms. According to the study of *Skibniewska* et al [31] the average fat content in the diets of students from Olsztyn was 39 g/day and was lower than the results obtained in the present study.

The percentage of energy from fat in the diets of both male and female students exceeded recommended by the National Food and Nutrition Institute 15-30% [9]. In relation to female diets these results were similar to those obtained in the WOBASZ study [2], where the average percentage of energy intake from fat was 34.8%. Furthermore, the percentage of energy from fat in the male diets in this study was higher than in the WOBASZ study, which was 37.5%. *Ilow* [8] also pointed out at the high percentage of energy from fat in daily food rations of male and female students, amounting respectively to 34% and 48.7%. In the present study, as same as in other research, excessive energy intake from fat in the daily food rations was observed [7, 23]. High energy intake from total fat in the students diets was due to the consumption of high-fat products, mainly of animal origin products.

The SFA content in the female diets was on average 29.1 g/day and in the diets of male 48.1 g/day. In other studies [8, 31] the similar content of SFA in the diets of students were presented. The percentage of energy from SFA in daily food rations in both groups of students from Wrocław showed a significant derogation from the recommendations and in the diets of female was 14.3% and 15.6% in the diets of male. These values were higher than those obtained in the WOBASZ study [2] (13.3% of the energy intake from SFA in the diets of female, 14.0% in the diets of male). However, in the POL-MONICA bis Warsaw study [29], in the age group 20-34 years, the average percentage of energy from the SFA in daily food rations of female was 12.3%, and in the diets of male 12.2%.

In a number of studies the influence of high intake of the SFA on the increase of total cholesterol level in blood serum was demonstrated [17,19,24,26]. Among the SFA important role in the CVD pathogenesis have myristic acid (C14:0) and palmitic acid (C16:0), whose metabolism has the strongest hypocholesterolemic effect. The importance of lauric acid (C12:0) is moderate while stearic acid (C18:0) and saturated fatty acids with a medium carbon chain length have a insignificant hypocholesterolemic effect. Stearic acid also exhibits the proaggregatory properties, that promote development of atherosclerosis in the arteries [6]. In the daily diets of female and male students the sum of palmitic, myristic and lauric acid accounted for respectively 65.6% and 69.0% of all the SFA. Furthermore, *Radzymińska* et al [28] indicated that the palmitic acid, lauric and myristic acid in daily food rations of university students accounted for 75.8% of all the SFA. Their main source in the daily diet were: pork fat, sausages, butter and dairy products and confectionery [15].

The average content of cholesterol in the female diets was 278.7 mg/day and in the male diets was 428.1 mg/day. The average diet of the three days in 79% of female contained less than 300 mg of cholesterol per day, while the cholesterol content in the average diet of three days in 70.1% of the male was higher and exceeded the allowed amount of 300 mg of cholesterol per day. This results were consistent with that of the *Snopek* et al study [33], in which in the diets of 70% of men, the cholesterol content exceeded the allowable amount. Assessment of dietary intake among university students from Poznań also showed excessive amounts of the cholesterol which exceeded the permitted level of 86% [1]. *Ilow* [8] also pointed out at a high amount of the cholesterol in the diets of Wroclaw university students.

The diet atherogenicity is defined as the potential ability to cause atherosclerosis lesions in blood vessels. Average value of the Keys score in the diet of female was 49.2 and exceeded the permitted range 30.1-35.5 for the study population. Average value of the Keys score for male was 52.3, with the permitted range 28.4-33.8. Average value of P/S ratio, both in female and male was incorrect and amounted to 0.4. Low value of P/S ratio indicates on a low content of the PUFA in the diet in relation to the SFA. In the WOBASZ study [2], the Keys score amounted to 45.7 in the diets of female and 47.8 in the diets of male. In the POL-MONICA bis study [29] the Keys score was lower (female 41.1, male 41.8), and the values of the P/S ratio were higher (female 0.7, male 0.6) than those obtained in the present study. Furthermore, *Szczuko* et al [37] showed that in the diets of male aged 22-24 years, the values of the Keys score and P/S ratio were also incorrect.

Increased intake of the MUFA at the expense of the SFA intake in the diets may cause antiatherosclerosis effect mainly because they help in lowering total cholesterol and LDL in the blood serum [25]. In the diets of 34% female and 63% male the percentage of energy from the MUFA was adequate, that was equal or exceeded 14%. Among the MUFA acids the oleic acid predominated, and accounted for 91% of energy intake from the MUFA. *Radzymińska* et al [28], also indicated that the oleic acid was dominated among the MUFA acids. However, *Skibniewska* et al [31] found that oleic acid accounted for an average of 38% the MUFA.

Results of epidemiological studies conducted in Greece clearly showed a positive effect of the Mediterranean diet in reducing CVD incidents in this country [41]. Beneficial effect was apparent in particular from the increased consumption of products which are rich sources of the oleic acid (n-9) and the PUFA n-6 and n-3 [21]. Therefore, the European and American scientific societies recommend the Mediterranean diet in the prevention of CVD [12, 20].

The content of the PUFA in the diets of female was on average 10.7 g/day, which represented 5.3% of daily energy intake. The PUFA content in the diets of male was on average 18.3 g/day, which represented 6.0% of daily energy intake. The irregularities in the consumption of the PUFA, which were demonstrated in this study confirm results observed in the WOBASZ study [2]. Furthermore, *Kris-Etherton* et al [14], in the study conducted among young Americans in 1989-1991 showed, that compared with our results, the average energy intake of the PUFA in the diets of female was higher and was 6.5%, while in male was lower and amounted to 5.9% of daily energy requirements. *Czupryńska* et al [32] also pointed out at the insufficient intake of the PUFA in the diets of students.

The dietary intake of α-linolenic acid (ALA-alpha-linolenic acid) according to the guidelines should be approximately 2 g/day, and the sum of EPA and DHA 0.2 g/day [9]. While the Polish Forum for Prevention of Cardiovascular Diseases recommended intake of n-3 (EPA, DHA) fatty acids in the amount of 1 g/day in secondary prevention of CVD [12]. The daily intake of total essential fatty acids (EFA) (C18:2 + C18:3) in the diets of female students was on average 10.4 g/day (LA was 8.9 g/day, and ALA 1.5 g/day). The EFA content in the diets of male students was on average 17.4 g/day (LA was 15.1 g/day, and ALA 2.3 g/day). Taking into account the recommendations the content of ALA in the diets of female was too low, and in the diets of male was at the recommended level. In order to supplement the deficiency of ALA in the diets of students, the intake of vegetable oils could be recommended. To cover the daily demand for ALA need just about 20 g of rapeseed oil (1.5 tablespoons), 29 g soybean oil (2.5 tablespoons) and 37g of wheat germ oil (3 tablespoons). A rich source of ALA are walnuts. The portion of 30g of walnuts is enough to cover the daily demand for this FA [15]. The sum of EPA and DHA in the diets of female was 0.1 g/day and the n-6/n-3- PUFA ratio was 5.8:1. In the diets of male the sum of EPA and DHA was 0.2 g/day, and n-6/n-3- PUFA ratio was 6.1:1. Both in the diets of male and female students n-6/n-3 PUFA ratio did not reach the recommended value. The sum of EPA and DHA in the diets of students did not cover the daily requirement for these acids. These results were similar to those involving young Americans [14].

Increasing intake of the *omega*-3 PUFA in relation to the omega-6 PUFA has a definitely beneficial effect on lipid profile in blood serum. The rich source of the *omega*-6 PUFA are vegetable oils (sunflower oil, soybean oil, corn oil, grapeseed oil, wheat germ oil and safflower oil) [15]. Students are therefore required to increase intake of products rich in EPA and DHA, while to decrease intake of the products which are the source of *omega*-6. The best sources of EPA and DHA are fatty marine fish [15]. Based on the recommendations proposed by the National Food and Nutrition Institute the average servings of marine fish needed to cover the demand for EPA and DHA in the group of students were proposed in Table 2.

Authors of the Physician's Health Study [26] observed that the consumption of more than one portion of marine fish per week reduced the risk of death from

CVD by 52%. The average content of fish marine in the diets of female was almost twice lower than in the diets of male and it was respectively 13.5 g/day and 24.3 g/day, which was the cause of the insufficient content of EPA and DHA. In order to fulfill the recommendations of daily supply of EPA and DHA from a diet the intake of fatty marine fish should increase. The authors of the Pol-MONICA bis study [29] showed a much lower consumption of fish, in the age group 20-34 years (female – 8.7 g/day, male-16.4 g/day) compared with the results obtained in the present study. Other authors [5, 40] also pointed out at the low consumption of fatty marine fish, which are the best source of the n-3 PUFA in the population of students.

Table 2. Selected fish species as a potential source of the recommended amount (1 g/day [12]) of the sum of EPA and DHA in the diet

Product	Σ (EPA+DHA) [15] [g/100g]	Portion of fish covering the recommended intake [g/day]
Smoked mackerel	2.70	37.0
Smoked herring „Pikling”	1.48	67.5
Sardines in oil	2.44	41.0
Herring in oil	1.31	76.5
Smoked eel	0.26	384.5
Smoked salmon	1.27	78.5

* Σ (EPA+DHA) – sum of the eicosapentaenoic acid and docosahexaenoic acid;

The content of the MUFA above and below 14% of energy intake in the students diets was the criterion for the allocation and assessment of the students diets (Table 3).

It was found that, in the most diets of students (59.9%), the energy intake from the MUFA was lower than recommended, so their health promoting properties probably did not have been used. It was observed that the energy intake from the SFA was increased both in the diets of students with the recommended amount of the MUFA (≥14%) and also in the diets of students with the reduced content of the MUFA (<14%) and ranged from 13.1 to 16.9%. In the diets of male, both in those in which the energy intake from the MUFA was <14% and in those ≥ 14%, comparable amounts of the SFA, except for the stearic acid, were observed. Products that are a good sources of the stearic acid are: pate of veal, pork, game meat, processed meat or fish and dairy products [15]. In the diets of female, both in those in which the energy intake from the MUFA was less than 14% as well as in those in which the energy intake from the MUFA was ≥ 14%, statistically significant differences in the contents of all SFA except for the butyric acid were observed. The main source of the butyric acid in the diet are dairy products [15]. Both in the diets with normal and excessive intake of the MUFA, the content of the PUFA differed significantly with the exception of DHA. In the diets of female consuming the recommended amounts of the MUFA significantly higher energy intake from the PUFA (C18:2, C18:3, C20:4) in comparison with the second group was observed. Lower content of EPA and DHA was also observed in those female who consumed recommended amounts of the MUFA that the others. The main source of the PUFA and EPA and DHA are respectively: vegetable products, red meat and marine fish. In the diets of male, both containing the correct and incorrect energy intake from the MUFA, comparable amounts of the PUFA, with the exception of the arachidonic acid, were observed. The main source of the arachidonic acid are meat products [15]. Those female who consumed recommended amounts of the MUFA had statistically significant higher energy intake, total fat and cholesterol intake, Keys score and statistically significant lower content of total carbohydrates and dietary fiber in their diets than the other group. In the diets of male students the recommended percentage of energy from the MUFA was correlated with higher total fat content in the diets and the Keys score. Furthermore, in the diets of female and male students disturbed the n-6/n-3 ratio, which an average was 5.2–6.9, as demonstrated.

CONCLUSIONS

1. Excessive content of the saturated fatty acids and the cholesterol, and also insufficient percentage of the energy from the monounsaturated and the polyunsaturated fatty acids in the students diet could contribute to atherosclerotic lesions since childhood and is a risk factor for CVD.
2. The Keys score used as an assessment criterion of atherogenicity of the diets indicated that most studied diets of female and all diets of male were atherogenic. Having regard to the sex as an independent risk factor for coronary heart disease may be assumed that the men are exposed to the occurrence CVD in the future.
3. The results also indicate the need to reduce the intake of the products that are sources of the SFA

Table 3. Energy value and average content of selected nutrients in daily food rations of female and male students. which diets contained <14% or ≥14% of energy from MUFA

Variable	Unit	Female (n=100)		I vs II p	Male (n=27)		I vs II p
		Group I (n=66)	Group II (n=34)		Group I (n=10)	Group II (n=17)	
		< 14%	≥ 14%		< 14%	≥ 14%	
		X ± SD	*X ± SD*		*X ± SD*	*X ± SD*	
Energy	%	1773.8 ± 379.0	1905.4 3± 38.0	0.0400	2547.5 ± 489.3	2840.4 ± 992.9	>0.05
Total proteins	g	61.2 ± 13.0	65.9 ± 16.1	>0.05	92.6 ± 26.8	113.9 ± 38.2	>0.05
Energy from proteins	%	13.7 ± 2.0	13.8 ± 2.5	>0.05	14.9 ± 3.3	15.4 ± 2.7	>0.05
Total carbohydrates	g	252.6 ± 57.8	217.9 ± 54.1	0.0231	317.5 ± 77.3	306.4 1 ± 12.2	>0.05
Energy from carbohydrates	%	51.7 ± 5.2	42.2 ± 4.5	<0.0001	47.1 ± 5.3	37.0 ± 4.8	>0.05
Dietary fiber	g	20.4 ± 7.4	16.6 ± 5.2	0.0100	22.3 ± 6.7	26.9 ± 14.4	>0.05
Total fats	g	63.6 ± 16.8	87.1 ± 19.9	<0.0001	95.0 ± 23.9	138.8 5 ± 4.8	0.0196
Energy from fats	%	32.2 ± 4.5	40.9 ± 3.8	<0.0001	33.3 ± 3.0	43.7 ± 5.6	0.0001
Cholesterol	mg	211.5 ± 72.3	290.4 ± 107.8	0.0005	339.0 ± 121.2	480.5 ± 258.5	>0.05
Keys score		44.7 ± 10.7	55.6 ± 10.7	<0.0001	46.2 ± 5.2	55.8 ± 10.0	0.0072
P/S ratio		0.4 ± 0.2	0.4 ± 0.2	>0.05	0.4 ± 0.1	0.4 ± 0.1	>0.05
Saturated fatty acids (SFA)							
Σ SFA	g	25.7 ± 8.6	35.7 ± 10.6	<0.0001	38.6 ± 10.9	53.7 ± 24.7	>0.05
Energy from SFA	%	13.1 ± 3.1	16.7 ± 3.1	<0.0001	13.5 ± 1.7	16.9 ± 3.1	0.0039
Butyric acid (C4:0)	g	0.5 ± 0.2	0.5 ± 0.2	>0.05	0.7 ± 0.4	0.7 ± 0.4	>0.05
Caproic acid (C6:0)	g	0.3 ± 0.1	0.4 ± 0.2	0.0306	0.5 ± 0.2	0.5 ± 0.3	>0.05
Caprylic acid (C8:0)	g	0.2 ± 0.1	0.3 ± 0.1	0.0002	0.4 ± 0.2	0.4 ± 0.2	>0.05
Capric acid (C10:0)	g	0.6 ± 0.3	0.8 ± 0.3	0.0005	0.9 ± 0.4	1.1 ± 0.7	>0.05
Lauric acid (C12:0)	g	1.0 ± 0.4	1.3 ± 0.5	0.0008	1.4 ± 0.6	1.7 ± 0.9	>0.05
Myristic acid (C14:0)	g	3.1 ± 1.4	4.3 ± 1.7	0.0002	4.7 ± 1.7	6.1 ± 3.7	>0.05
Pentadecanoic acid (C15:0)	g	0.3 ± 0.2	0.5 ± 0.2	<0.0001	0.5 ± 0.2	0.8 ± 0.5	>0.05
Palmitic acid (C16:0)	g	13.4 ± 4.3	18.7 ± 5.7	<0.0001	20.5 ± 5.6	29.2 ± 13.5	>0.05
Heptadecanoic acid (C17:0)	g	0.2 ± 0.1	0.3 ± 0.1	<0.0001	0.4 ± 0.1	0.5 ± 0.3	>0.05
Stearic acid (C18: 0)	g	5.9 ± 2.0	8.3 ± 2.5	<0.0001	8.3 ± 2.4	12.5 ± 5.0	0.0255
Arachidic acid (C20:0)	g	0.1 ± 0.1	0.2 ± 0.1	<0.0001	0.2 ± 0.0	0.2 ± 0.1	>0.05
Polyunsaturated fatty acids (PUFA)							
Σ PUFA	g	10.1 ± 4.7	12.0 ± 4.2	0.0109	15.4 ± 5.8	19.9 ± 7.2	>0.05
Energy from PUFA	%	5.1 ± 1.8	5.7 ± 1.6	>0.05	5.4 ± 1.4	6.4 ± 1.4	>0.05
Linoleic acid (C18:2) n-6	g	8.6 ± 4.3	9.7 ± 3.4	0.0228	13.1 ± 5.7	16.3 ± 6.3	>0.05
α-linolenic acid (C18:3) n-3	g	1.3 ± 0.5	1.9 ± 0.8	<0.0001	1.8 ± 0.6	2.6 ± 1.1	>0.05
Arachidonic acid (C20:4) n-6	g	0.1 ± 0.1	0.1 ± 0.1	0.0001	0.1 ± 0.1	0.2 ± 0.1	0.0038
(C18:2) + (C18:3)	g	9.8 ± 4.6	11.6 ± 3.9	0.0090	14.9 ± 6.1	18.9 ± 7.1	>0.05
Eicosapentaenoic acid –EPA (C20:5) n-3	g	0.07 ± 0.16	0.06 ± 0.12	0.0231	0.07 ± 0.09	0.10 ± 0.22	>0.05
Docosapentaenoic acid -DPA (C22:5) n-3	g	0.02 ± 0.03	0.02 ± 0.03	0.0258	0.02 ± 0.17	0.03 ± 0.05	>0.05
Docosahexaenoic acid -DHA (C22:6) n-3	g	0.08 ± 0.18	0.08 ± 0.18	>0.05	0.07 ± 0.10	0.15 ± 0.32	>0.05
EPA + DHA	g	0.2 ± 0.3	0.17 ± 0.33	0.0201	0.2 ± 0.2	0.3 ± 0.6	>0.05
n-6/n-3 ratio		6.9 ± 3.1	5.2 ± 1.2	0.0139	6.7 ± 1.9	6.2 ± 2.7	>0.05

* X ± SD – average ± standard deviation; p<0.05= statistically significant; p>0.05= statistically insignificant; SFA - saturated fatty acids; MUFA – monounsaturated fatty acids; PUFA - polyunsaturated fatty acids; P/S – polyunsaturated fatty acids/saturated fatty acids

and the cholesterol and increase consumption of the products abundant in the MUFA and the omega-3 PUFA, which have antiatherosclerosis activity.
4. Summarizing the results of the study may be stated that the prevention programs for cardiovascular disease should be also directed at young people.

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