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POLYUNSATURATED FATTY ACIDS AND NOT PLANT STEROLS NATURALLY-OCCURRING IN FOOD INFLUENCE LIPID PROFILE IN OBESE WOMEN

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ABSTRACT

Background. The aim of this study was to assess the influence of the consumption level of plant sterols naturally occurring in diet on the lipid profile in obese women with dyslipidemia.
Material and methods. The study population was primarily comprised of 120 obese women aged over 55 from Poland, with twenty seven subjects dropping out of the study due to the inclusion and exclusion criteria. Anthropometric appraisal included body height and weight, as well as waist and hip circumferences. Lipid profile was determined by commercially available enzymatic methods. Nutritional data, including plant sterols intake were assessed by 7-day food records.
Results. The multiple linear regression, adjusted for age, height, Body Mass Index and Waist to Hip Ratio, showed the relation of polyunsaturated fatty acids with LDL-cholesterol concentration ($p < 0.05$). Natural plant sterols intake was estimated at Median = 146 mg/day. The correlation between LDL-cholesterol concentration and plant sterols intake was not statistically significant ($p > 0.05$).
Conclusions. The results of this study suggest that consumption of naturally-occurring polyunsaturated fatty acids and not plant sterols is connected with lower LDL-cholesterol concentration in obese women.

Key words: polyunsaturated fatty acids, plant sterols, lipid profile, dyslipidemia, obesity

INTRODUCTION

Improper nutritional habits are the cause of many dietary-dependent diseases [Engbers et al. 2006]. The main cause of such a state is the long-lasting positive energy balance, high cholesterol intake and high saturated fat intake combined with sedentary lifestyle which may result in obesity and atherosclerosis [Webber 2003, Hu 2003]. The main risk factor for atherosclerosis is the elevated LDL cholesterol (LDL-C) level, which may be normal in obesity and hypertension and leads to the development of cardiovascular diseases (CVD) [Elmadfa and Freisling 2009]. According to the data of World Health Organization, ischaemic heart disease is the main cause of deaths in high-, middle- and low-income countries [WHO 2008]. Therefore, new methods of non-pharmacological treatment of dyslipidemia are looked for.

The plant-origin nutritional compounds, such as phytosterols and their derivatives, have recently arisen scientific interests. The main natural sources of plant sterols (PS) in human nutrition are: plant oils, cereal

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products, fruit and vegetables [Piironen et al. 2000]. In some European countries, the mean intake of PS in basic diet was estimated at 150-400 mg/day, excluding the vegetarian diet (400-750 mg/day) [Davidson et al. 2001, Normén et al. 2002, 2007]. However, there is no recommendation for PS from naturally occurring phytosterols. According to results from the report of the members of the European Food and Safety Authority (EFSA), the recommended value of PS supplementation should oscillate around 1.6 g/day [EFSA 2008].

The positive influence of dietary-added PS is connected with the improved lipid profile with reduction of the total cholesterol (TC) concentration and LDL-cholesterol (LDL-C) fraction [Andersson et al. 2004, Gylling and Miettinen 1999, 2009 a, Gylling and Puska 1999, Gylling et al. 2009 b, 2010 a, 2010 b]. Previous studies evaluated the probable beneficial influence of PS naturally-occurring in a basic diet, and its improvement on the lipid profile, but they are not unequivocal and were carried out in varied populations [Normén et al. 2001, Valsta et al. 2004, Andersson et al. 2004, Klingberg et al. 2008, Sanclemente et al. 2009, 2012, Escurriol et al. 2009 a, 2009 b, Sioen et al. 2011, Han et al. 2009]. According to National Health and Nutrition Examination Survey, the percentage of women with hypercholesterolemia increases significantly over the age of 50, which shows that this population is at particular risk [Ford et al. 2003]. Therefore, the research has been focused on the representative group of obese women with dyslipidemia.

The aim of this study was to assess the influence of the consumption level of plant sterols naturally-occurring in diet on the lipid profile in obese women aged over 55 suffering from dyslipidemia.

MATERIAL AND METHODS

This study was carried out in 2009/2010 in Poznań (Poland). The research protocol was approved by the Poznań University of Medical Sciences Bioethical Committee. One hundred twenty obese females from Western Poland over the age of 55 participated in this study. Free-living participants who volunteered were recruited for a 16-week study. The subjects were sequentially enrolled in the study. The inclusion criteria included: Body Mass Index (BMI) > 30 kg/m², serum TC > 200 mg/dl and LDL-C > 100 mg/dl [WHO 2007]. The exclusion criteria consisted of: hipolypemic pharmacotherapy, CVD, consumption of products with added phytosterols during last 3 months, vegetarian-dietary habits and hormonal replacement therapy. Twenty-two females had hypertension. Seven participants had cardiac arrhythmias. None of the subjects used glucose lowering drugs nor statins. Nobody smoked. Taking into consideration the inclusion and exclusion criteria, 93 females were qualified for further research. The subjects gave their written consent for the study. The study was performed in accordance with Helsinki Declaration.

The anthropometrical parameters included the measurement of body weight and height using SECA digital scale (Hamburg, Germany) with an approximation of 0.5 cm and 0.1 kg, as well as waist and hip circumferences (assessed with the means of a flexible tape with an approximation of 0.1 mm) respectively. BMI and Waist to Hip Ratio (WHR) were calculated to identify the obesity within the studied group [Cole 1990]. Additionally, lipid profile containing serum TC, HDL-cholesterol (HDL-C) and serum triglycerides (TG) was determined by enzymatic colorimetric methods (Roche Diagnostics Corp., Indianapolis IN) in all the studied subjects [Allain et al. 1974, Matsuzaki et al. 1996, Roeschlau et al. 1974, Siedel et al. 1993, Sugiuchi et al. 1995]. The LDL-C was calculated according to Friedewald et al. [1972]. All blood samples were collected after an overnight 12-h fasting. Characteristics of the studied group is presented in Table 1.

The women were advised to continue their habitual diet. The dietary intake was evaluated by 7-day food records with a dietician checking the completion of data (Dietetyk, National Institute of Food and Nutrition, Warsaw, Poland). The local tables of food portion sizes and the weights of foods displayed in photos were used to estimate the amounts of food consumed according to the food records that were converted to gram weights. The weighment method was used as the standard for estimating the nutrient intake. Several nutritional factors including total energy, proteins, fats, plant sterols, saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA), dietary fiber, carbohydrates, cholesterol, folic acid, vitamins B6, vitamin B12, vitamin C, vitamin E and vitamin A were surveyed. An amount of PS in 96 food items was considered to estimate total PS intake

Table 1. Characteristic of the study group of obese women

Variables (n = 93)	Median	1st quartile	3rd quartile
Age, year	57.0	54.1	62.2
BMI, kg/m²	34.2	32.2	37.4
WHR	0.87	0.83	0.91
TC, mg/dl	242.8	219.3	261.6
LDL-C, mg/dl	155.2	130.8	174.3
HDL-C, mg/dl	58.9	49.8	71.2
TG, mg/dl	125.8	97.8	161.9

BMI – body mass index, WHR – waist to hip ratio, TC – total cholesterol, LDL-C – LDL-cholesterol, HDL-C – HDL-cholesterol, TG – total triglycerides.
Reference values: TC < 200 mg/dl, LDL-C < 100 mg/dl, HDL-C > 40 mg/dl, TG < 150 mg/dl [Moore et al. 2006].

as well as individual PS intake. Plant sterols content were obtained from a database of Polish foods. Statistica 10.0 Software was used for the statistical analysis. The level of significance was set at $\alpha = 0.05$. The multiple linear regression model, where the concentration of LDL-C fraction was assumed to be a dependent variable, was used.

RESULTS

The characteristics of the selected nutrients was presented in Table 2. The median total energy of daily food rations (DFR) in the studied group exceeded 1750 kcal [Jarosz and Bułhak-Jachymczyk 2008]. The mean PS intake naturally occurring in food was estimated to be low (Median = 146 mg/day). Campesterol and sitosterol were the main consumption fractions. The percentage intake of fatty acids and other nutrients differed from a recommendation [Jarosz and Bułhak-Jachymczyk 2008, FAO/WHO 2008].

The obtained results show the relation of PUFA with LDL-C concentration in multiple linear regression adjusted for age, height, BMI and WHR (Table 3). The relation between PS consumption and LDL-C concentration was not found ($p > 0.05$). For the value of total PS, the LDL-C concentration was maintained at the constant level of approx. 150 mg/dl. The correlations between other cholesterol fractions and phytosterols were not significant. Pearson's coefficient of correlation between PUFA and PS intake, as well as PUFA and sitosterol intake, were 0.22 and 0.20 respectively.

Table 2. Selected nutrients intake in the group of studied women

Variables (n = 93)	Median	1st quartile	3rd quartile
Energy, kcal	1 807	1 495	2 116
Protein, % of energy	17.0	15.1	18.6
Fat, % of energy	32.6	29.4	37.6
SFA, %	11.5	10.3	12.8
MUFA, %	12.1	10.6	14.3
PUFA, %	5.57	4.61	7.04
Carbohydrates, %	54.5	48.0	58.3
Dietary fibre, g	20.2	18.0	24.4
Cholesterol, mg	395	294	515
Plant sterols, mg	146	121	192
Campesterol, mg	22.9	17.3	35.1
Sitosterol, mg	91.5	69.9	119.6
Other plant sterols*, mg	31.6	35.6	34.6
Folic acid, µg	77.3	56.8	105
Vitamin B6, mg	1.99	1.74	2.26
Vitamin B12, µg	1.51	0.69	1.51
Vitamin C, mg	203	98.7	203.5
Vitamin E, mg	13.2	7.91	13.2
Vitamin A, µg	1 264	758	1 264

SFA – saturated fatty acids, MUFA – monounsaturated fatty acids, PUFA – polyunsaturated fatty acids.
*Include stigmasterol and unspecified plant sterols and stanols.

Table 3. The effect of chosen nutrients intake on LDL-C concentration

Analysed parameter (n = 93)	Model adjusted for: age, height, BMI, WHR	
	p-value	standardized β
Energy, kcal	0.054 (NS)	0.569
Protein, g	0.207 (NS)	–0.225
PUFA, g	0.014	–1.161
Plant sterol, mg	0.915 (NS)	–0.018
Campesterol, mg	0.169 (NS)	–0.167
Sitosterol, mg	0.166 (NS)	0.222
Folic acid, µg	0.174 (NS)	–0.158
Vitamin B6, mg	0.123 (NS)	0.205
Vitamin B12, ug	0.248 (NS)	–0.119
Vitamin C, mg	0.165 (NS)	0.158

PUFA – polyunsaturated fatty acids.
Statistical significance of multiple linear regression if p-value < 0.05.
NS – not significant.

DISCUSSION

According to database search, this is the first study evaluating the influence of the naturally-occurring PS and fatty acids in the representative group of significantly obese women aged over 55 suffering from dyslipidemia.

Comparing with the previously described studies, the median intake of naturally-occurring PS in habitual diet in the studied group of women was lower [Normén et al. 2001, Valsta et al. 2004, Andersson et al. 2004, Klingberg et al. 2008, Sanclemente et al. 2009, 2012, Escurriol et al. 2009 a, 2009 b, Sioen et al. 2011, Han et al. 2009]. Escurriol et al. [2009 a] estimated PS intake on higher level in Mediterranean diets. Nonetheless, a small number of participants in each group was a relevant limitation of this study. Another study from this author also found higher intake of PS in comparison with current study [Escurriol et al. 2009 b]. Even higher intake of PS among Spanish population was shown by Sanclemente et al. [2009]. Indeed, in this region of Europe high intake of PS is observed, which has been confirmed in the recent report [Sanclemente et al. 2012]. This fact can be connected with a widespread use of traditional food products, which are good sources of PS. It should be emphasized that PS intake from traditional diet is different and depends on the region [Han et al. 2009]. Additionally, a higher level of PS intake in the studied group of women and especially among men was estimated in the Dutch's study [Normén et al. 2001]. Finally, Swedish and Belgian researchers also obtained similar results [Valsta et al. 2004, Klingberg et al. 2008, Sioen et al. 2011]. The intake of PS in the first quartile was estimated at the similar level of the current study only among English women [Andersson et al. 2004].

The relationship between PS naturally-occurring in food and cholesterol concentration obtained in our study was similar with the results of Sanclemente et al. [2009]. On the other hands, Andersson et al. [2004] documented a negative trend between blood lipids (TC and LDL-C) and PS intake. The mean concentration of TC for women consuming high amounts of PS was 0.15 mmol/l lower and for LDL-C 0.13 mmol/l lower than among those with the lowest consumption. Having considered the factors such as age, BMI and menopausal status, Klinberg et al. [2008] observed lower total cholesterol (3.5%) and LDL-C (3.2%) but only in the fifth quantile of PS diet's density. Escurriol et al. [2009 a] and Han et al. [2009] also documented the beneficial effect of phytosterols from natural sources on cholesterol level. Lin et al. [2010] concluded that PS in a healthy diet has the influence on cholesterol metabolism. Nevertheless, that is not reflected in circulating LDL-C. In the current study, the intake of PS was low and did not show the influence on lipid profile.

The beneficial influence of PUFA on TG and HDL-C has been documented [Psota et al. 2006, Yokoyama et al. 2007, Moore et al. 2006]. In the case of LDL-C concentration, data are contradictory [Abellán et al. 2011, Pedersen et al. 2005, Woo et al. 1997, Zambon et al. 1999]. Nevertheless, as shown by extensive epidemiological research, a slight decrease of TC and LDL-C concentration is noted also during the increased supply of PUFA [Erkkila et al. 2008]. In the present study, the relationship between PS and LDL-C concentration was documented in the cross-sectional study. However, it only occurred with the reference

to the unique group with dyslipidemia. Potentially, as suggested by Micallef and Garg [2008], PUFA and PS may have complimentary influence on lipid profile among patients suffering from hypercholesterolemia. The main natural sources of PS and PUFA are common e.g. plant oils, but we have to pay attention that other sources which occur in the diet and are rich in PS are not rich with PUFA and *vice versa* (e.g. fishes, fruits, vegetables). In the current study Pearson's coefficient of correlation between PUFA and PS was low, showing the importance of non oil sources. The results of this study suggest that consumption of naturally-occurring fatty acids among obese women is connected mainly with lower LDL-cholesterol concentration.

It appears that longitudal intake of polyunsaturated fatty acids naturally-occurring in food can have a beneficial effect in prophylaxis of dyslipidemia development. This aspect is undoubtedly important especially in the context of growing percentage of subjects with obesity and dylipidemia [Ford et al. 2003]. Moreover, higher risk of the development of cardiovascular diseases was observed among postmenopausal women, which was also confirmed by The Centers for Disease Control and Prevention [CDC 1999]. Furthermore, focusing research on the group of obese postmenopausal women with dyslipidemia underlines the propriety of such research in the context of ischemic heart disease risk and is of the greatest importance in relation to cardiovascular disease.

CONCLUSIONS

In conclusion, the results of this study suggest that consumption of naturally-occurring polyunsaturated fatty acids and not plant sterols is connected with lower LDL-cholesterol concentration in obese women.

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WPŁYW WIELONIENASYCONYCH KWASÓW TŁUSZCZOWYCH I STEROLI ROŚLINNYCH NATURALNIE WYSTĘPUJĄCYCH W ŻYWNOŚCI NA PROFIL LIPIDOWY OTYŁYCH KOBIET

STRESZCZENIE

Wstęp. Celem pracy była ocena wpływu poziomu spożycia steroli roślinnych naturalnie występujących w diecie na profil lipidowy u kobiet otyłych z dyslipidemią.

Materiał i metody. Badaną populację tworzyło 120 kobiet otyłych, powyżej 55 roku życia z Polski, z czego 27 osób nie spełniało kryteriów włączenia do badań. Pomiary antropometryczne obejmowały: masę i wysokość ciała, obwód talii i bioder. Profil lipidowy oznaczono za pomocą komercyjnych metod enzymatycznych. Dane żywieniowe, obejmujące poziom spożycia steroli roślinnych, oceniono za pomocą 7-dniowego wywiadu żywieniowego.

Wyniki. W analizie regresji wielorakiej – skorygowanej o wiek, wysokość ciała, wskaźnik masy ciała oraz wskaźnik talia-biodro – wykazano związek pomiędzy spożyciem wielonienasyconych kwasów tłuszczowych a stężeniem LDL-cholesterolu ($p < 0,05$). Medianę poziomu spożycia naturalnie występujących steroli roślinnych oszacowano na 146 mg/dzień. Korelacja pomiędzy stężeniem LDL-cholesterolu a podażą steroli roślinnych nie była istotna statystycznie ($p > 0,05$).

Wnioski. Wyniki przeprowadzonych badań sugerują, iż spożycie naturalnie występujących wielonienasyconych kwasów tłuszczowych, a nie steroli roślinnych, jest związane z mniejszym stężeniem LDL-cholesterolu u kobiet otyłych.

Słowa kluczowe: wielonienasycone kwasy tłuszczowe, sterole roślinne, profil lipidowy, dyslipidemia, otyłość

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