

## ASSESSMENT OF FOOD INTAKES FOR WOMEN ADOPTING THE HIGH PROTEIN *DUKAN* DIET

Joanna Wyka\*, Ewa Malczyk, Marta Misiarz, Marzena Zołoteńka-Synowiec,  
Beata Całyniuk, Sandra Baczyńska

Institute of Dietetics, University of Applied Sciences in Nysa, Ujejskiego street 12, 48-300 Nysa, Poland

### ABSTRACT

**Background.** Overweight and obesity are metabolic disorders affecting both adults and children. Effective treatment of these conditions is focused on decreasing the body mass, through individually tailored and well balanced diets, along with increasing physical activity. Obese persons often, however, choose high protein diets for losing weight. Recently in Poland, the high-protein *Dukan*-diet has become very popular.

**Objectives.** To assess dietary consumption in women adopting the *Dukan*-diet, including intakes of protein, fat, carbohydrate as well as vitamins and minerals.

**Materials and Methods.** Subjects were 51 women aged 19-64 years on the *Dukan*-diet, who were surveyed by individually conducted interview. Women were asked to provide typical menus from each phase of their diets. Quantitative dietary intake assessment was achieved by an officially used 'Photograph album of foodstuffs and dishes' as custom-designed by the National Food and Nutrition Institute (IZZ) in Warsaw.

**Results.** Protein intakes in all subjects were excessive, especially those of animal origin when compared to recommended nutritional standards. In contrast, dietary carbohydrate intakes were low due to poor consumption of fruit and vegetables. Mineral and vitamin intakes revealed high potassium, iron and vitamins A, D and B<sub>2</sub>, but low vitamin C and folates. Women's average weight reduction after 8-10 weeks of dieting was approximately 15 kilograms.

**Conclusions.** Many nutritional abnormalities were found in women on the high protein *Dukan*-diet. Adopting this diet in the long-term may pose health threats through acquiring kidney and liver disease, osteoporosis and cardiovascular disease.

**Key words:** obesity, high protein diet, nutrients

### STRESZCZENIE

**Wprowadzenie.** Otyłość i nadwaga są chorobami metabolicznymi, które dotyczą zarówno dorosłych, jak i dzieci. Właściwym postępowaniem w leczeniu tych chorób jest zmniejszenie masy ciała poprzez zastosowanie indywidualnej, dobrze zbilansowanej diety oraz zwiększenie aktywności fizycznej. W celu redukcji masy ciała otyli pacjenci czasami decydują się na zastosowanie diety wysokobiałkowej. W Polsce, w ostatnich latach, bardzo popularna jest wysokobiałkowa dieta *Dukana*.

**Cel.** Celem badań była ocena sposobu żywienia kobiet stosujących dietę wysokobiałkową *Dukana*. Oceniono zawartość białek, tłuszczów, węglowodanów, a także witamin i składników mineralnych w diecie badanych kobiet.

**Materiały i metody.** Badanie zostało przeprowadzone za pomocą 24-godzinnej wywiadu przeprowadzonego indywidualnie z każdą respondentką. W badaniu wzięło udział 51 kobiet w wieku 19-64 lat stosujących wysokobiałkową dietę *Dukana*. Kobiety poproszono o podanie przykładowego jadłospisu z każdej fazy diety. Do oszacowania w wielkości (w gramach) spożytej żywności wykorzystano „Album fotografii produktów i potraw” opracowany przez Instytut Żywności i Żywienia w Warszawie.

**Wyniki.** Kobiety biorące udział w badaniu spożywały nadmierną ilość białka, szczególnie pochodzenia zwierzęcego, w stosunku do zalecanych norm żywieniowych. Zawartość węglowodanów w racjach pokarmowych była niska i wynikała z małej podaży warzyw i owoców. Wśród ocenianych składników mineralnych stwierdzono najniższe spożycie potasu i żelaza, a najwyższe fosforu i sodu. Wykazano także, że ze stosowaną dietą niska była podaż witaminy C i folianów, natomiast wysoka witamin A, D i B<sub>2</sub>. Wśród badanych kobiet, średnia redukcja masy ciała po 8-10 tygodniach stosowania diety wynosiła około 15 kilogramów.

**Wnioski.** U kobiet stosujących wysokobiałkową dietę *Dukana* stwierdzono wiele nieprawidłowości żywieniowych. Długotrwałe stosowanie tej diety może zwiększyć ryzyko zdrowotne związane z wystąpieniem chorób nerek i wątroby, osteoporozy oraz chorób sercowo-naczyniowych.

**Słowa kluczowe:** otyłość, dieta wysokobiałkowa, składniki odżywcze

\*Corresponding author: Joanna Wyka, Institute of Dietetics, University of Applied Sciences in Nysa, Ujejskiego street 12, 48-300 Nysa, Poland, phone +48 77 409 16 52, e-mail: joanna.wyka@pwsz.nysa.pl

## INTRODUCTION

Overweight and obesity are metabolic diseases which are an ever rising problem in Poland as well as the majority of economically developed countries of the world. The WOBASZ study on overweight and obesity undertaken in Poland, has shown these symptoms in 61.6% men and 50.3% women [1]. Above all, these were found to arise from excess calorific dietary intake relative to its utilization [2]. Effective treatment of obesity requires long-term therapy and a cooperation between the patient with a multi-disciplinary team of dietician, doctor, psychologist, physiotherapist and personal trainer. The therapy is based on a multi-tier education of the obese person, together with an individualised and well balanced diet having a negative energy balance [21, 34]. Patience and being consistent are traits needed for keeping to such diets. Obese patients however, usually wish for quick results in losing weight and they have often also tried slimming on several previous occasions – without any lasting success.

Diets of varying nutrient content have become popular in recent times, of which the most well known are the single component types, with a preponderance of protein [4, 6, 8]. The popularity of high protein diets (i.e. >25% of protein derived calories) are because of their rapid effects and no limits placed on how much high protein foodstuffs are to be consumed [5]. Such diets, where high protein is coupled to low carbohydrate, lead to rapid weight loss where, amongst other things, this is caused by having reduced ghrelin levels; a hormone produced by gastric parietal cells responsible for reducing hunger pangs. Ghrelin concentrations decrease mainly due to dietary carbohydrate deficiencies, followed by protein then fats. A carbohydrate-poor diet leads to dehydration, where together with the utiliza-

tion of glycogen stores from muscle and liver, water is removed from the body at a rate of 2-3 g water per 1 g glycogen [3, 10, 22, 27].

Within the Polish scientific literature, not much data has been gathered on the health impact of the long term adoption of either high protein or high fat diets intended for losing body mass [2, 20]. Results from the rest of the world are from short-term studies that indicate a clear body weight loss arising from low calorie diets, vitamin and mineral intake deficiencies as well as in renal function disorders due to increased glomerular filtration of toxic products from nitrogen metabolism [16, 32]. The long-term adoption of high protein diets may lead to hyper-filtration, glomerular overload and proteinuria. Filtered protein damages renal tubules and upon entering the interstitial tissue, inflammation results. Likewise, a diet containing processed meat products, rich in protein, delivers excessive phosphates leading to the development of secondary hyperthyroidism. Furthermore, a high protein diet causes increased metabolic acidosis, a characteristic of advanced renal failure [13, 15, 17, 28].

The study aim was to perform a dietary assessment of those women on a high protein *Dukan*-diet, based on surveying their menus from each of the diet's 4 phases.

## MATERIALS AND METHODS

The study surveyed 51 women subjects aged 19-64 years, that were on the *Dukan*-diet with no limits placed for food consumption. The 'Snowball Sampling' method was used for their recruitment i.e. a non-random sample selection dependent on existing subjects recruiting others of their acquaintance [26, 29]. An assessment was performed by individual interview for each subject on the nutrition over the last 24 hours.

Table 1. Energy and nutrients in diet of women adopting the high protein *Dukan* diet according to the diet's phase

Calories and nutrient content	Phase I	Phase II	Phase III	Phase IV
	x ±SD (% of standards)			
Calories [kcal]	888.0±558.0 (44.4%)	1020.0±303.7 (51%)	1014.0 ±407.0 (50.7%)	1008.0 ±482.0 (50.4%)
Protein [g]	109.0 ±18.2 (167.6%)	116.0 ±15.6 (178.4%)	87.0 ±14.8 (133.8%)	114.0 ±13.6 (175.3%)
Fat [g]	34.7 ±27.2 (51.0%)	33.3 ±16.3 (50.0%)	60.9 ±21.0 (92.2%)	48.7 ±19.6 (72.7%)
Carbohydrate [g]	39.7 ±17.8 (13.6%)	70.3 ±25.8 (24.5%)	30.8 ±15.6 (10.5%)	30.7 ±17.8 (10.7%)
<b>Minerals</b>				
Calcium [mg]	675.0 ±256.0 (67.5%)	1003.0 ±311.0 (100.0%)	860.0 ±311.0 (86.0%)	954.0 ±372.0 (95.0%)
Iron [mg]	7.8 ±2.4 (43.3%)	11.7 ±3.8 (65.0%)	9.3 ±3.1 (51.6%)	5.3 ±1.4 (29.4%)
Sodium [mg]	1751.0 ±572.0 (116.0%)	1862.0 ±422.0 (124.1%)	1392.0 ±379.0 (92.8%)	1698.0 ±497.0 (113.2%)
Potassium [mg]	2129.0 ±645.0 (45.2%)	3464.0 ±582.0 (73.0%)	2911.0 ±602.0 (61.9%)	2335.0 ±645.0 (49.6%)
Phosphorus [mg]	1670.0 ±207.0 (238.5%)	1312.0 ±197.0 (187.4%)	1526.0 ±251.0 (218.0%)	1706.0 ±232.0 (243.0%)
<b>Vitamins</b>				
A [µg]	1386.0 ±158.0 (198.0%)	1383.0 ±563.0 (197.0%)	1523.0 ±488.0 (217.0%)	1331.0 ±165.0 (190.0%)
D [µg]	7.6 ±3.5 (152.0%)	5.9 ±2.5 (118.0%)	5.5 ±2.0 (110.0%)	6.3 ±3.7 (126.0%)
B2 [mg]	2.0 ±0.5 (181.0%)	2.6 ±0.7 (236.0%)	1.9 ±0.6 (172.0%)	2.1 ±0.7 (190.0%)
C [mg]	2.7 ±1.7 (3.6%)	4.5 ±2.6 (6.0%)	2.5 ±1.9 (3.3%)	3.9 ±2.3 (5.2%)
Folate [µg]	120.0 ±53.0 (30.0%)	105.0 ±43.0 (26.2%)	155.0 ±62.0 (38.7%)	99.0 ±39.0 (24.7%)

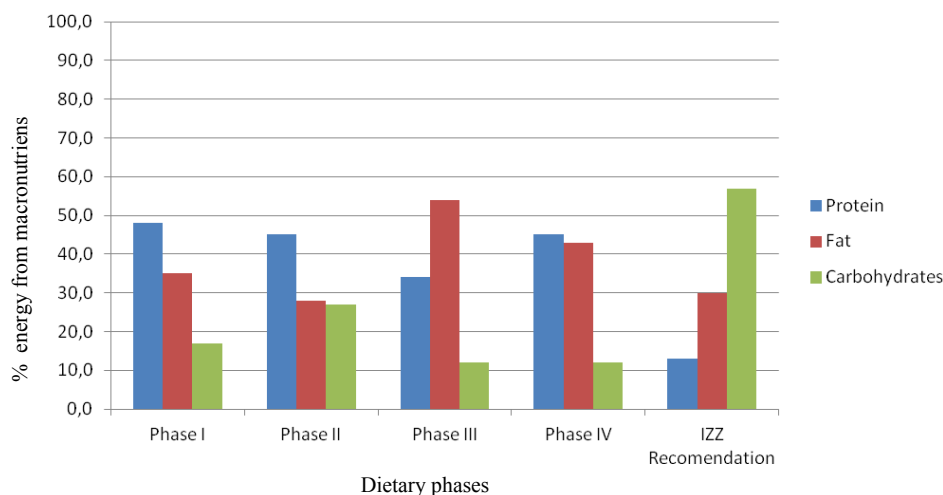


Figure 1. Dietary calories derived from protein, fat and carbohydrate for women adopting a high protein diet according to the diet's phase

Women subjects were asked to provide a typical daily menu from the I, II, III and IV phases of their diet. In phase I they consumed high protein foodstuffs, whilst in the ensuing phases, other products could also be introduced; in phase II some vegetables were allowed, phase III some fruit and starch products whilst phase IV only permitted high protein foodstuffs with a so called 'pure protein day' once per week. Quantitative dietary intakes were determined by using the aforementioned 'Photograph album of foodstuffs and dishes' as custom-designed by the IZZ in Warsaw [30].

Menus were evaluated by the 'Dieta 5' computer programme using a data base compiled by *Kunachowicz et al.*, also from the IZZ [14]. Additional information was gathered on body mass and height before, during and after dieting. The diet's calorific value and nutrient content were compared to recommended Polish nutritional standards [11] for each subject. From these, calorific values were taken as those appropriate to the body mass of each subject when there are low levels of physical activity and assuming that dietary calories are derived from 13% protein, 30% fat and 57% carbohydrate. Dietary vitamin and mineral values were also compared to either the Recommended Daily Allowance (RDA) or the Adequate Intake (AI) for adult women.

Table 1 presents the mean dietary calorific and macronutrient content (i.e. protein, fat and carbohydrate) along with minerals (calcium, iron, potassium and phosphorus) and vitamins (A, D, B<sub>2</sub>, C and folates) during each phase of the *Dukan* diet and the proportion that this covers the recommended standards. Mean dietary calories derived from each macronutrient (i.e. protein, fat and carbohydrate), for the average diet of each subject were compared to those recommended by the IZZ. The subjects were broken down into 3 age groups as follows; 40% aged 19-30 years, 47% aged 31 to 51 years and 13% aged 51-64%. Before dieting, the

BMI could be grouped into the following ranges; 47% women (25-29.9), 47% (30-34.9) - 1st degree obesity, and 6% (35-39.9) 2nd degree obesity.

## RESULTS

For the phase I, high protein diet, the mean dietary calorific values were 888.0 kcal (Table 1) which covered the recommended standards for each subject by an average of 44.4%, whilst mean protein intakes were 109 g making up a mean of 167.7% to the recommended standards. Mean dietary fat intakes of 34.7 g covered these standards by 51% and those for carbohydrates were respectively 39.7 g and only 13.6%. Calcium intake made up 67.5% of the recommendations. The mean body mass loss during phase I was 2.4 kg. In the following phases, similar nutrient contents were observed. Phase III showed intakes of 87 g protein and 60 g fat which are closer to standards set. Because of the diet's low calorific value (1014 kcal), the proportion of calories in this phase that is derived from specific nutrients differs most from the WHO/IZZ recommendations (Figure 1). Calories derived from protein, fat and carbohydrate during phase III are respectively 34%, 54% and 12% (Figure 1). In phase II, the highest body mass reduction was found; on average by 10.6 kg. The dietary intakes in phase IV demonstrated the greatest iron and potassium deficiencies of respectively 29.4% and 49.6% to the standards as well as having the highest excess of phosphorus that covered 243.0% of standards. Dietary intakes of vitamin C and folates were very low in all phases; being respectively 3-6% and 24-38% of the standards. During dieting after 8-10 weeks, the average body mass loss was by around 15.0 kg.

## DISCUSSION

Despite introducing preventative and therapeutic programmes of education that deal with obesity each year to the general public worldwide, attempts to globally reduce the adverse increases in body mass have proved ineffective. Additionally, obesity is recognised to be a risk factor in many other metabolic diseases, together with hypertension, diabetes and cardiovascular disease; all falling into the category of the Metabolic Syndrome (MS). Obesity requires long-term treatment, which at present focuses on lifestyle and genotype, but equally also extra-nutritional factors such as economic-social status, education and mental health. The effectiveness of a rational and safe reductive diet, as recommended by WHO/IZZ, is conditional on consistently and thoroughly keeping to its principles. Patients however expect quick outcomes, which directly serves to motivate them in seeking unconventional and fashionable diets. Nonetheless, very few are aware of the adverse health effects in adopting such dieting.

By reducing carbohydrate intakes, high-calorie foodstuffs become excluded, like pizza, pasta or bread thereby decreasing a diet's calories by around 500 kcal. Limiting dietary energy intake forms the basis of all slimming diets, as does having a normally balanced diet to achieve body mass loss. During deficiencies in dietary carbohydrate intake, free fatty acids are metabolised from which ketone bodies arise. Ketosis status is an important factor for inhibiting appetite [6]. In the first days of adopting the diet, various processes occur leading to the body losing water, such as glycogen mobilisation from muscle or the liver; a glycogen loss of 400 g reduces water by 1 kg. Another cause of dehydration is the excretion of ketone bodies in the urine. Adopting a high protein diet carries the potential risk for elevated serum homocysteine concentrations, which is a sulphur containing amino acid produced by methionine metabolism present in animal meat protein. For homocysteine to become adequately metabolised, then vitamin B group vitamins and folates are required in sufficient amounts; as delivered through the diet. Dietary deficiencies of these vitamins are observed in women adopting high protein diets leading to blood vessel damage and may result in arteriosclerosis [25].

Studies on healthy subjects eating high protein diets have been unable to show any disorders in glomerular filtration. Nevertheless, an increased excretion of calcium, urates and phosphates was observed which may lead to kidney stone formation [12, 24]. Disturbing the acid-base balance, as a result of high dietary protein intake, also increases the risk of osteoporosis [19, 33]. Excessive consumption of animal derived protein, being a rich source of purines, increases serum concentrations of uric acid, that leads to hypertension and renal function

disorders. The advantages of rapid weight loss of high protein diets needs to be reconciled with the potential health threats such as advancing renal and cardiovascular disease. Extensive recent studies have compared the effectiveness for reducing body mass by adopting diets supplying various macronutrients [7].

In summary, the authors stress that the greatest body mass loss was seen after 6 months of adopting each diet (arising from a decreased calorie intake) amounting to around 6 kg. Following 2 years of following a 15% or 25% protein diet, the loss of body mass were respectively 3 and 3.6 kg. An approximate 3.3 kg body mass loss was observed in those adopting a 20% and 40% fat diet, whilst subjects on 65% and 35% carbohydrate diets lost respectively 2.9 kg and 3.4 kg. When discussing the dietary role of protein, *Te Morenga* and *Mann* [31] emphasised that body mass loss in those obese subjects adopting high protein diets arises from reduced calorific intakes. Taking up such eating habits may lead to an increased cancer risk through excessive red meat consumption as well as lowering blood pressure and evening-out the blood lipid profile.

The presented study demonstrated a reduced risk of contracting diabetes for those taking up a high protein diet through improved glycaemic control and insulin resistance. Following a 55-60% carbohydrate diet with 15% protein or a 40-45% carbohydrate diet with 25-30% protein together with taking physical exercise, led to the following to become lowered; insulin resistance index by 0.2, BMI by 6.8% and body adipose tissue in studied teenagers by 2.4%. When comparing the health benefits of adopting high carbohydrate, protein and fat diets in 96 women subjects (BMI<27), *McAuley* et al. [18] found that, after 8 weeks, all 3 diets caused body mass loss, reduced waistline and decreased serum triglycerides. Blood insulin was significantly reduced in women following high protein and high fat diets compared to those adopting a high carbohydrate diet.

## CONCLUSIONS

1. Women taking up high protein diets demonstrated deficient calorific intake which was responsible for the lowering of body mass.
2. The women's diet had low contents of carbohydrate, calcium, iron, potassium, vitamin C and folates but excessive amounts of protein, phosphorus, sodium along with vitamins A and D.
3. Adopting a high protein diet in the long term may be harmful to health.

Conflict of interest

*The authors declare no conflict of interest.*

## REFERENCES

1. Biela U., Pajk A., Kaczmarczyk-Chalas K., Gluszek J., Tendera M., Waśkiewicz, A., Kurjata P., Wyrzykowski B.: Częstość występowania nadwagi i otyłości u kobiet i mężczyzn w wieku 20-74 lat. Wyniki programu WO-BASZ. *Kardiol Pol* 2005;63:4-6.
2. Bolesławska I., Przysławski J., Schilegel-Zawadzka M., Grzymalski M.: The content of mineral compounds in daily food rations taken by men and women under traditional and low carbohydrate 'optimal' diet. *Żyw Nauka Technol Jakość* 2009;4:303-311 (in Polish).
3. Bowen J., Noakes M., Trenerzy C., Clofion P.M.: Energy intake, ghrelin, and cholecystokinin and protein preloads in overweight men. *J Clin Endocrinol Metab* 2006;91(4):1477-1483.
4. Denke M.A.: Metabolic effects of high-protein, low-carbohydrate diets. *Am J Cardiol* 2001;8:59-61.
5. Dukan P.: *Metoda doktora Dukana*. Kraków, Wyd. Otwarte, 2009.
6. Dytfeld J., Kujawska-Luczak M., Pupek-Musialik D.: Controversy of low-carbohydrate diet. *Diabetol Doświad Klin* 2005;5(5):337-344 (in Polish).
7. Frank M. S., Bray G.A., Carey V.J., Smith S.R., Ryan H.D.: Comparison of weight-loss diets with different compositions of fat, protein, and carbohydrates. *N Engl J Med* 2009;360:859-73.
8. Gardnem C.D., Kiazand A., Alhassan S., Kim S., Stafford R.S., Balise R.R., Kraemer H.V., King A.C.: Comparison of the Atkins, Zone, Ornish Diets for change in weight and related risk factors among overweight premenopausal women. *JAMA* 2007;9:969-977
9. Garnett S. P., Gow M., Ho M., Baur L. A., Noakes M., Woodhead H.J., et al.: Improved insulin sensitivity and body composition, irrespective of macronutrient intake, after a 12 month intervention in adolescents with pre-diabetes; RESIST a randomized control trial. *BMC Pediatr* 2014;14:289-299.
10. Gil-Campos M., Aguilera C.M., Canete R., Gil A.: Ghrelin: a hormone regulating food intake and energy homeostasis. *Br J Nutr* 2006;96:201-226.
11. Jarosz M.: *Praktyczny podręcznik dietetyki*. Warszawa, Wyd. IŻŻ, 2010.
12. Johnston C.S., Tjonn S. L., Swan P.D.: Low-carbohydrate, high-protein diets that restrict potassium-rich fruits and vegetables promote calciuria. *Osteoporos Int* 2006;17:1820-1821.
13. Kubit P.: Rola białka w leczeniu chorób nerek. *Dietetyka* 2007;1(2):15-16.
14. Kunachowicz H., Nadolna I., Iwanow K., Przygoda B.: *Wartość odżywcza wybranych produktów spożywczych i typowych potraw*. Warszawa, Wyd. PZW, 2012.
15. Kwaśniewska A.: High protein diet controversies. *Bromat Chem Toksykol* 2011;2:271-276 (in Polish).
16. Lagiou P., Sandin S., Lof M., Trichopoulos D., Adami H.O., Weiderpass E.: Low carbohydrate- high protein diet and incidence of cardiovascular diseases in Swedish women: prospective cohort study. *BMJ* 2012;344:1-11.
17. Majdan M., Borys O.: Dna i schorzenia towarzyszące podwyższonemu stężeniu kwasu moczowego. *Rocz Pom Akad Med w Szczecinie* 2010;56(1):34-39.
18. McAuley K.A., Hopkins C. M., Smith K.J., Malcy R.T., Williams S.M., Taylor R.W., Mann J.I.: Comparison of high-fat and high-protein diets with a high-carbohydrate diet in insulin-resistant obese women. *Diabetologia* 2005;48:8-16.
19. Noworyta-Ziętara M., Miazgowski T., Krzyżanowska-Świniarska B., Ogonowski J.: Does obesity protect against osteoporosis? *Endokrynol Otyłość Zaburz Przem Materii* 2008;4(2):69-77 (in Polish).
20. Olszanecka-Glinianowicz M.: Dieta proteinowa Dukana – co powinni o niej wiedzieć lekarze. *Med Prakt* 2011;4(242):64-70.
21. Ostrowska L., Stefańska E., Adamska E., Talałaj E., Waszczeniuk M.: Effect of treatment with reducing diet on body composition and modification of nutrients in daily food intake in obese women. *Endokrynol Otyłość Zaburz Przem Materii* 2010;6(4):179-188 (in Polish).
22. Polińska B., Matowicka-Karna J., Kemona H.: The role of ghrelin in the organism. *Post Hig Med Dośw* 2011;65:1-7 (in Polish).
23. Poortmans J.R., Dellalieux O.: Do regular high-protein diets have potential health risk on kidney function in athletes? *Int J Sports Nutr* 2000;10:28-398.
24. Reddy S. T., Wang C.Y., Sakhaee K., Brinkley L., Pak C. Y.: Effect of low carbohydrate high-protein diets on acid-base balance, stone forming propensity, and calcium metabolism. *Am J Kidney Dis* 2002;40(2):265-274.
25. Sicińska E., Wyka J.: Folate intake in Poland on the basis of literature from last ten years (2000-2010). *Rocz Panstw Zakl Hig* 2011;62(3):247-256 (in Polish).
26. Sobaś K., Wądołowska L., Słowińska M.A., Człapka-Matyasik M., Niedzwiecka E., Szczepańska J.: Analysis of characteristic models of calcium consumption by mother-daughter pairs. *Probl Hig Epidemiol* 2011;92(1):54-62 (in Polish).
27. Stookey J., Constant F., Popkin B.M.: Drinking water is associated with weight loss in overweight dieting women independent of diet and activity. *Obesity* 2008;16(11):2481-2488.
28. Szczęch R., Narkiewicz K.: Hiperurykemia i dna moczowa. *Choroby Serca i Naczyń* 2006;3:167-168.
29. Szczepańska J., Wadołowska L.: Study of the frequency of consuming of the selected sources of fat in women of various weight and fat of body. *Bromat Chem Toksykol* 2011;44(3):290-297 (in Polish).
30. Szponar L., Wolnicka K., Rychlik E.: *Album fotografii produktów i potraw*. Warszawa, Wyd. IZZ, 2000.
31. Te Morenga L., Mann J.: The role of high-protein diets in body weight management and health. *Br J Nutr* 2012;108:130-138.
32. Thorpe M.P., Jacobson E.H., Layman D.K., He X., Kris-Etherton P.M., Evans E.M.: A diet high in protein, dairy, and calcium attenuates bone loss over twelve months of weight loss and maintenance relative to a conventional high-carbohydrate diet in adults. *J Nutr* 2008;138:1069-1100.

- 
33. Tkaczuk-Włach J., Sobstyl M., Jakiel G.: Osteoporoza - obraz kliniczny, czynniki ryzyka i diagnostyka. *Przegl Menop* 2010;9(2):113-117.
34. Tsigos C., Hainer V., Basdevant A., Finer N., Fred M., Malthus-Vliegen E., Micic D., Maislos M., Roman G., Schulz Y., Topkal H., Zahorska-Markiewicz B.: Management in obesity in adults: European clinical practice guidelines. *Endokrynol Otyłość Zaburz Przem Materii* 2009;5(3):87-98 (in Polish).

Received: 12.12.2014

Accepted: 08.04.2015