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ORIGINAL ARTICLE

ASSESSMENT OF GLYCEMIC LOAD AND INTAKE OF CARBOHYDRATES IN THE DIETS OF WROCLAW MEDICAL UNIVERSITY STUDENTS (POLAND)

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ABSTRACT

Background. Glycemic Load (GL) is one of the indicators that can be used to assess the nutritional value of the diet. The results of numerous studies have shown that high glycemic index and/or high GL diets were associated with increased risk for type 2 diabetes, cardiovascular disease and cancer.

Objectives. The aim of the study was to evaluate dietary GL, intake of food products which are source of carbohydrates and contribution of particular carbohydrates in students' diets.

Material and Methods. The study group consisted of 140 female students from Wroclaw (Poland) aged 21±1.6 years. The dietary assessment was performed using food frequency-questionnaire. The GL of daily food ration (DFR) was considered low for values <80 g, medium for values between 80-120 g and high for values >120 g.

Results. The mean GL of the diets was 120.7±42 g. DFR of 12.1% of the students had low GL, 46.6% - medium, and 39.3% - high. Diets in the 4th quartile of GL were characterized by the highest energy value, total carbohydrate, sucrose, starch and fiber content and energy contribution from carbohydrates when compared with lower quartiles. Higher percentage of energy from protein and fats in the diets was related with lower dietary GL. The highest correlation coefficient between GL and weight of the consumed food was observed for sweets (r=0.67), cereal products (r=0.52), juices and sweetened beverages (r=0.50), vegetables (r=0.45) and fruits (r=0.44). In the study, cereal products, fruits, sweets, vegetables and juices and sweetened beverages consumed by the female subjects constituted respectively 26.6%, 12.8%, 11.4%, 9.1% and 8.8% of the total dietary GL.

Conclusions. Lower dietary GL in the female students participating in the study can be achieved by limiting the intake of sweets and sweet beverages as well as consuming cereal products with a low GI.

Key words: *glycemic index, glycemic load, carbohydrates, students, diet*

STRESZCZENIE

Wprowadzenie. Ładunek glikemiczny (ŁG) jest jednym ze wskaźników, na podstawie którego można ocenić wartość odżywczą diety. W licznych badaniach stwierdzono, że wysoki indeks i/lub ŁG diety były związane ze zwiększonym ryzykiem rozwoju cukrzycy typu 2, chorób sercowo-naczyniowych oraz nowotworowych.

Cel. Celem badań była ocena wartości ładunku glikemicznego (ŁG), udziału produktów będących źródłem węglowodanów oraz struktury węglowodanów w dietach studentek dietetyki Uniwersytetu Medycznego we Wrocławiu.

Materiał i metody. Grupę badaną stanowiło 140 studentek, których średni wiek wynosił 21±1,6 lat. Ocenę spożycia żywności przeprowadzono z wykorzystaniem food frequency-questionnaire (FFQ). ŁG całodziennej racji pokarmowej uznano za niski dla wartości <80 g, średni dla wartości 80-120 g i wysoki >120 g.

Wyniki. Średnia wartość ŁG diet wynosiła 120,7±42 g. Diety 12,1% badanych kobiet miały niski ŁG, 46,6% średni, a 39,3% wysoki ŁG. Diety należące do czwartego kwartyla pod względem ŁG w porównaniu z kwartylami: pierwszym, drugim i trzecim, charakteryzowały się największą wartością energetyczną, zawartością węglowodanów ogółem, sacharozy, skrobi i błonnika pokarmowego oraz udziałem energii z węglowodanów. Większy udział energii z białka i tłuszczów w dietach był związany z niższym ŁG diety. Najwyższą wartość współczynnika korelacji między ŁG a masą spożytych produktów stwierdzono dla słodyczy (r=0,67), a następnie dla produktów zbożowych (r=0.52), soków i napojów słodzonych (r=0,50), warzyw (r=0,45) i owoców (r=0,44). Sumaryczny ŁG diet badanych osób w 26,6% pochodził z produktów zbożowych, w 12,8% z owoców, w 11,4% ze słodyczy, 9,1% z warzyw oraz 8,8% z soków i napojów słodzonych.

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Wnioski. Zmniejszenie wartości ŁG diet badanych kobiet można osiągnąć poprzez ograniczenie spożycia słodyczy i słodzonych napojów oraz wybieranie produktów zbożowych o niskim indeksie glikemicznym.

Słowa kluczowe: *indeks glikemiczny, ładunek glikemiczny, węglowodany, studenci, dieta*

INTRODUCTION

Carbohydrates are main source of energy in properly balanced diet. The chemical structure of carbohydrates is diverse, what determine their diverse properties and is reflected in dietary recommendations. It is recommended to intake 50% to 70% of energy from carbohydrates, including 10 to 20% of calories from sugars and not more than 10% of added sugars [30]. An adequate intake of dietary fiber for adults is 20 to 25 grams per day [9].

From a nutritional point of view, a dominant is an effect of carbohydrates on postprandial glycaemia and depending on the glycaemic index (GI) value of foods. The GI is defined as the measurement of the effect of 50 g digestible carbohydrates of a test food on blood glucose level compared to the effect of 50 g glucose. GI of various food products can be rated as low (GI < 55), medium (55-70) or high (> 70) [2]. However GI is not a precise measurement to estimate nutritional value of daily food ration (DFR), because it is determined experimentally and it should not be computed for mixed dishes. Moreover GI does not include real portion of consumed carbohydrates. Better measurement to estimate nutritional value of DFR is glycaemic load (GL), which is calculated based on the GI and the portion size of food eaten [GL= (GI x carbohydrate per serving)/100] [17].

The results of numerous studies have shown that high GI and/or high GL diets were associated with increased risk for type 2 diabetes [1, 26], cardiovascular disease (CVD) [16, 33] and cancer [28, 29]. Based on a meta-analysis conducted by *Schwingshackl* and *Hoffmann* [27] it was found beneficial effects of long-term use of a low GI/GL diet with respect to fasting insulin and pro-inflammatory markers such as C-reactive protein. Moreover *Liu* et al. [13] observed lower fasting high-density-lipoprotein cholesterol (HDL-C) level and higher fasting plasma triglyceride (TG) with increasing dietary GL in study group.

The aim of the study was to evaluate dietary GL, intake of food products which are source of carbohydrates and contribution of particular carbohydrates in students' diets.

MATERIAL AND METHODS

The study group included 140 female dietetics students of Wroclaw Medical University, Poland. The average age of students was 21±1.6 years. Dietary habits in the study group were evaluated by validated food frequency-questionnaire (FFQ) [4]. The study was conducted in 2013. The questionnaire contained 154 food items. The servings were specified as commonly used portion sizes (e.g. one average banana, one ice cream scoop, one slice of bread) or household measures (e.g. spoon, teaspoon, plate, cup). The food groups from the food frequency questionnaire that were assessed included: milk and dairy products, fruits, vegetables, meat, fish and eggs, bread and cereal products, mixed dishes, beverages and snacks. Participants were asked to indicate their usual frequency of intake during the last year of each food item, choosing from nine frequency categories: „never or less than once a month", „one to three per month", „one per week", „two to four per week", „five to six per week", „one per day", „two to three per day", „four to five per day" or „six or more times per day". Frequency of consumption of each food item in the FFQ was converted to intake in grams per day by multiplying the given serving size of each food and appropriate factors of frequency. Afterwards the nutritional value of DFR was computed by using "Food Composition Tables" [8].

GL values of individual foods were calculated by multiplying a food's GI by the number of digestible carbohydrates in a given serving. There are not many polish studies where GI of food products would be examined [12, 15] and therefore GI values of individual foods were read from international tables wherein GI values were determined experimentally for many food products and dishes [5, 20]. GL values for typical Polish dishes were computed based on their recipes [8].

GLs of DFRs were calculated by summing GL values of consumed foods. GL of 80 g or below was considered low, a GL of 80-120 g was considered medium, and a GL of 120 g or above was considered high. GL of diets was assessed based on contribution in diet: cereals, fruits, vegetables, sweets, juices, sweetened beverages and soups. Daily intake of other products such as: potatoes, French fries, sugar, honey, raisins, walnuts, seeds, dairy products and the following meals: fried breaded food products, dumplings and oatmeal with milk was also taken into consideration.

Statistical analysis

The obtained results were summarized by average (X), standard deviation (SD), median (M), the lowest and the highest quartile. To estimate relationship between dietary GL and total energy intake, carbohydrates, proteins and fats contents and intake of individual food groups was used *Pearson's* linear correlation test. Correlation was considered as weak for statistically significant correlation coefficient (R) value below 0.4, for R between 0.4 and 0.6 was considered as moderate and for R above 0.6 was

considered as strong. A nutritional value of diet grouped by quartile of their GL was compared by *Kruskal-Wallis* test for non-parametric variables. Differences were considered statistically significant at $p < 0.05$. Statistical analysis was performed using the software STATISTICA 10 (StatSoft Inc., USA).

RESULTS

Table 1 presents the average value of GL, energy intake and content of carbohydrates, proteins and fats in the diets of surveyed female students. The average value of dietary GL was 120.7 ± 42 g. Low GL (< 80 g) was observed in 12.1% of analyzed diets, while medium GL (80-120 g) and high GL (> 120 g) was observed respectively in 48.6% and 39.3% of the students diets. The diets were characterized by low energy intake from carbohydrates (46.2 ± 6%), however the average content of dietary fiber (30.4 ± 11.2 g per day) was consistent with the recommendations. The average energy intake from protein and fat amounted to 16.1 ± 2.6% and 35.8 ± 5.2%, respectively.

Table 1. Glycemic load, energy intake and carbohydrates, protein and fat content in the diets of the studied female students

Variables	X ± SD	Lower quartile	Median	Upper quartile
Glycemic load (g)	120.7 ± 42.0	93.3	111.4	137.4
Energy (kcal)	2064.8 ± 600.7	1649.0	1961.7	2396.1
Carbohydrates (g)	269.0 ± 87.0	211.7	255.6	304.9
Carbohydrates (% of energy)	46.2 ± 6.0	43.0	46.5	50.3
Sucrose (g)	59.0 ± 26.8	39.3	53.4	69.6
Lactose (g)	19.2 ± 12.2	10.3	16.4	25.7
Starch (g)	96.7 ± 37.6	70.9	91.6	114.0
Dietary fiber (g)	30.4 ± 11.2	23.3	28.8	34.8
Protein (g)	82.9 ± 26.4	63.3	80.1	103.3
Protein (% of energy)	16.1 ± 2.6	14.5	15.9	17.2
Fats (g)	82.4 ± 27.3	62.7	77.7	99.8
Fats (% of energy)	35.8 ± 5.2	32.4	35.6	39.3

X ± SD -average ± standard deviation

The diets belonging to the fourth quartile (Q4) of the GL, in comparison with the first (Q1), second (Q2) and third (Q3) quartile, were characterized by the highest value of energy, intake of total carbohydrate, sucrose, starch and dietary fiber and the percentage of energy from carbohydrates (Table 2). The starch content in the surveyed students diets increased with the increasing dietary GL. No statistically significant differences in the energy intake from carbohydrates between diets belonging to Q1, Q2, and Q3 were recorded. Furthermore, no differences were observed between diets from Q2 and Q3 in terms of energy intake, total carbohydrate, sucrose, lactose and dietary fiber. There was no statistically significant difference in analyzed diets belonging to each GL quartiles in relation to energy intake from protein and fats. Other relationships between diets belonging to each GL quartile are shown in Table 2.

Table 2. Comparison of the daily energy intake and macronutrients content in the diets of the study group, classified into GL quartiles

Variable	Quartile 1 (Q1)	Quartile 2 (Q2)	Quartile 3 (Q3)	Quartile 4 (Q4)
Glycemic load (g)	77.3 ± 11.7^{a,b,c}	103.8 ± 5.2^{d,e}	122.6 ± 7.1^{f}	178.9 ± 35.7
Energy (kcal)	1445.5±237.3^{a,b,c}	1863.8 ± 228.3^{e}	2154.1 ± 324.0^{f}	2795.8 ± 516.6
Carbohydrates (g)	177.5 ± 29.9^{a,b,c}	242.1 ± 23.1^{e}	272.2 ± 29.0^{f}	384.3 ± 74.9
Carbohydrates (% of energy)	44.1 ± 7.6^{c}	46.1 ± 4.9^{e}	45.3 ± 5.1^{f}	49.4 ± 4.6
Sucrose (g)	37.0 ± 13.3^{a,b,c}	51.0 ± 9.9^{e}	57.5 ± 17.8^{f}	90.5 ± 27.3
Lactose (g)	15.3 ± 11.0^{e}	19.4 ± 11.0	18.1 ± 10.9	24.0 ± 14.2
Starch (g)	62.8 ± 19.1^{a,b,c}	83.0 ± 15.6^{d,e}	102.1 ± 15.6^{f}	139.0 ± 41.1
Dietary fiber (g)	20.7 ± 6.9^{a,b,c}	29.3 ± 6.6^{e}	31.3 ± 7.7^{f}	40.4 ± 12.7
Protein (g)	60.0 ± 20.0^{a,b,c}	77.0 ± 17.8^{e}	89.5 ± 23.0	105.2 ± 21.8
Protein (% of energy)	16.4 ± 3.6	16.4 ± 2.3	16.4 ± 2.3	15.1 ± 1.8
Fats (g)	59.5 ± 18.0^{a,b,c}	74.6 ± 17.2^{e}	88.6 ± 20.9	107.0 ± 26.7
Fats (% of energy)	36.5 ± 6.7	35.7 ± 5.1	36.6 ± 4.2	34.3 ± 4.3

small letters means statistically significant differences between quartiles: a - Q1 vs Q2; b – Q1 vs Q3; c – Q1 vs Q4; d – Q2 vs Q3; e – Q2 vs Q4; f – Q3 vs Q4

Table 3. Correlation between dietary glycemic load and energy and macronutrient intake in the diets of the study female students, described by the *Pearson* correlation coefficient

Variables	R	*p*
Energy (kcal)	0.90	0.00
Carbohydrates (g)	0.96	0.00
Carbohydrates (% of energy)	0.38	0.00
Sucrose (g)	0.82	0.00
Lactose (g)	0.22	0.01
Starch (g)	0.85	0.00
Dietary fiber (g)	0.68	0.00
Protein (g)	0.64	0.00
Protein (% of energy)	-0.26	0.002
Fats (g)	0.69	0.00
Fats (% of energy)	-0.18	0.036

R – *Pearson's* correlation coefficient, *p* – statistically significant

Table 3 presents the relationship between dietary GL and energy intake and the content of carbohydrates, proteins and fats in the students diets, described by the *Pearson* correlation coefficients. Strong positive correlation between the dietary GL and the energy intake as well as carbohydrate, proteins and fats intake was observed. Moreover, the dietary GL was positively correlated with the energy intake from carbohydrates. Whereas the higher energy intake from protein and fats affected the reduction of the dietary GL.

Average daily intake of the groups of food products and their caloric value, content of carbohydrates, dietary fiber and GL are presented in Table 4. The total GL of cereal products, which the average daily intake amounted to 149.6 g, was the highest among all the assessed groups. These products were also the main source of carbohydrates in women diets and the third source of dietary fiber. The GL of fruits and vegetables was significant in the summary dietary GL, because of their high consumption that amounted respectively to 336.4 g and 421.4 g. These products simultaneously were the main source of dietary fiber (53.6%). In the analyzed diets the third place in total GL had sweets and their average daily intake was 52.2 g. Cereal products accounted 26.6% of the total dietary GL, while fruits, sweets, vegetables and juices and sweetened beverages accounted respectively 12.8%, 11.4%, 9.1%, 8.8% (Figure 1).

In Table 5 the relationship described by the *Pearson* correlation coefficient (R), between the weight of consumed food products and the total diet GL are presented. The highest value of R between the dietary GL and the products consumption was recorded for sweets (0.67). Moderate correlation, between the GL and the mass of consumed products, for: cereals, juices and carbonated beverage, vegetables, fruits and dumplings was found. Although the intake of certain groups of products, eg. soups or dairy products, was much higher than sweets, the correlation between dietary GL and their intake was weak, due to the low content of carbohydrate in these products.

Table 4. Average daily intake of particular groups of food products and their energy value, total carbohydrate and fiber content and glycemic load (GL)

Products	Intake (g/day)	Energy (kcal/day)	Carbohydrates (g/day)	Dietary fiber (g/day)	GL
Cereals	149.6 ±81.3	272.4 ±149.2	60.2 ±32.9	6.4 ±3.8	32.1 ±18.6
Fruits	336.4 ±217.2	168.7 ±105.9	43.9 ±27.6	6.8 ±4.3	15.5 ±9.7
Vegetables	421.4 ±241.2	207.9 ±115.1	34.2 ±20.7	9.5 ±5.6	11.0 ±7.2
Potatoes and french fries	49.1 ±40.5	60.4 ±47.6	10.1 ±8.1	0.8 ±0.7	5.7 ±4.7
Juices and sweetened beverages	219.8 ±191.8	93.3 ±80.9	22.4 ±19.3	0.7 ±0.8	10.6 ±9.4
Sweets	52.2 ±38.6	194.0 ±151.4	26.4 ±21.8	0.5 ±0.5	13.8 ±12.2
Sugar and honey	10.4 ±12.3	37.4 ±45.2	9.2 ±11.1	0.0 ±0.0	5.7 ±7.0
Raisins dried	8.8 ±13.5	24.5 ±37.5	6.3 ±9.6	0.6 ±0.9	3.7 ±5.6
Nuts and seeds	23.5 ±24.3	133.2 ±137.3	4.6 ±4.8	1.7 ±1.7	0.5 ±0.5
Milk and dairy products	355.5 ±231.3	296.3 ±152.4	18.5 ±12.6	0.1 ±0.2	5.8 ±4.0
Dishes					
Soups	216.5 ±154.7	86.5 ±57.3	13.7 ±9.2	2.1 ±1.7	6.2 ±4.1
Breaded fried products	54.5 ±41.1	143.6 ±107.1	4.3 ±3.3	0.3 ±0.2	2.9 ±2.3
Dumplings with meat and with potato filling	16.4 ±21.4	29.3 ±38.7	3.8 ±4.9	0.2 ±0.2	2.5 ±3.2
Soup milk with rolled oats	87.0 ±115.2	53.9 ±71.4	7.1 ±9.4	0.5 ±0.7	3.5 ±4.7

GL – glycemic load

Table 5. Correlation between the consumption of particular groups of food products and the glycemic load of the diets of the female students, described by the *Pearson* correlation coefficient

Products	R	*p*
Sweets	0.67	0.00
Cereals	0.52	0.00
Juices and sweetened beverages	0.50	0.00
Vegetables	0.45	0.00
Fruits	0.44	0.00
Dumplings	0.41	0.00
Potatoes	0.37	0.00
Sugar and honey	0.32	0.00
Soups	0.30	0.00
Raisins dried	0.24	0.00
Breaded fried products	0.24	0.00
Nuts and seeds	0.19	0.03
Milk and dairy products	0.16	0.06
Soup milk with rolled oats	0.11	0.18

R – Pearson's correlation coefficient, p – statistically significant

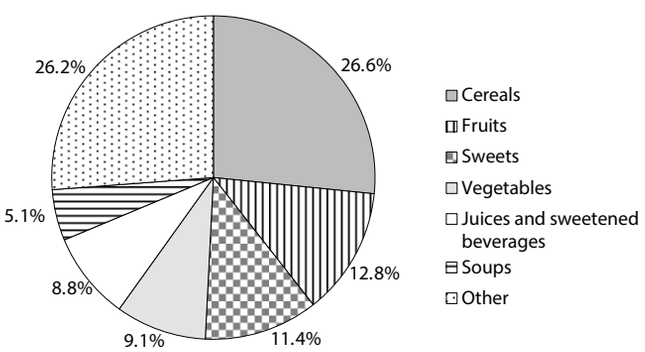

Figure 1. Contribution of selected groups of food products in total glycemic load of the diets of the female students

DISCUSSION

GL is one of the indicators that can be used to assess the nutritional value of the diet. The consumption of low GI foods, that contains slow-digestible carbohydrates, promotes to maintain proper blood glucose concentration. As a result the hyperglycemia does not appear, as well as hypoglycemia caused by the action of insulin, which is manifested by a sudden feeling of hunger. Diet with low GI foods promotes regularly nutrition and avoidance snacking during the day. Some benefits arising from the consumption low GI foods were described by *Ukleja* et al. [31]. *Warren* et al. [32] demonstrated that children who ate low GI breakfast, more frequently during the lunch ate low calories meals compared to children whose breakfasts contains a high GI products. The authors suggested that eating a low GI meals may be the important step in body weight control and obesity treatment [32]. This is confirmed by the results obtained by *Murakami* et al. [18], who showed that higher dietary GL correlated with increased risk of overweight and abdominal obesity in children and adolescents. In another study, a reduction in waist circumference and waist-to-hip ratio (WHR) in patients with excess body weight was observed among those on a diet with a low GI compared to those on a diet with a high GI. Statistically significant changes were recorded after 15 days from the beginning of the study [3].

In Polish reference there are a few studies [23,24] which evaluated dietary GL, while the numerous authors of studies conducted in the world have considered this problem [11, 19, 25]. *Murakami* et al. [19] evaluated the value of GL in diets of 3931 dietetics students from Japan. It was higher than estimated in this study and amounted to 147 g. It should be pointed out that the average daily energy intake in Japan students diets was 1822 kcal per day and the energy intake from carbohydrates was 55.2%. In their diets the white rice accounted 45.8% of the total dietary GL. In a study conducted among 40-69 years old population from the United States, the average daily energy intake from the diet, carbohydrate intake, and dietary GL amounted to 1964 kcal, 220.5 g and 128.3 g, respectively [11]. Diets of 70-80 year-old men and women participating in the Health, Aging and Body Composition Study were characterized by the GL amounted to 145.2 and 118.3 g, respectively. The average daily energy intake and the content of carbohydrates amounted respectively to 2082 kcal and 273 g in the diets of men and 1710 kcal and 228 g in the diets of women [25].

In the present study the dietary GL was positively correlated with the energy intake from carbohydrates and negatively correlated with the energy intake from protein and fat. It may therefore resulted in wrong conclusions to recommend a low-carbohydrates diet with a high content of protein and/or fat. However it would not be correct as evidenced by the study results conducted by *McMillan-Price* et al. [14]. The authors compared the impact of four diets, differing in content and type of carbohydrates and content of protein, on weight loss and reduction of cardiovascular risk in young adults with excess body weight. First of the analyzed diets contained 55% of energy from carbohydrates with high GI. Second of the diets contained 55% of energy from carbohydrates with low GI. The diet number 3 contained 25% of energy from protein and carbohydrates products with high GI, while the diet number 4 contained also 25% of protein but the carbohydrates products with low GI. The dietary GL of each diet amounted respectively 116, 65, 84 and 43 g. The authors observed that each

of the analyzed diet were favorable to weight loss, wherein the lowest effect was noticeable for the first diet and the highest for the second diet. After 12 weeks of the study, in patients applying different diets has been observed statistically significant differences in total cholesterol concentration and LDL cholesterol concentration, as well as leptin concentration in blood serum. The diet number 2 resulted in a reduction in total cholesterol and LDL cholesterol concentration respectively by 0.18 and 0.17 mmol/l, however the 3rd diet resulted in an increase concentration of these parameters respectively by 0.24 and 0.26 mmol/l. The 4th diet (high protein + low GI foods) contributed to the reduction of total cholesterol and LDL cholesterol concentration by only 0.05 and 0.04 mmol/l, and was less effective than a diet containing 55% of energy intake from carbohydrates with a low GI foods. The 2nd diet was the most effective in reducing leptin concentration in blood serum, a hormone involved in the regulation of food intake. The authors also observed that the dietary GL was significantly correlated with the glucose and insulin concentration in the blood serum [14]. Beneficial to health is therefore reasonably balanced diet containing the low GI foods.

Analyzing dietary GL it is worth to pay attention to food products which influence on the total value of GL and the degree of correlation between the intake of these products and the increase of GL. In the present study the highest contribution in the total GL of students diets had cereal products, which were also the main source of carbohydrates. However, the correlation coefficient between the dietary GL and the intake of these products (r=0.52) was in the second place. The strongest positive correlation was observed between the GL and sweets consumption (r=0.67), although this group of products had the third contribution in the dietary GL and was the fourth source of carbohydrates. Significant part of the GL value of analyzed diets had also fruits and vegetables, but recommendations indicate to not limit their consumption because they are the source of many valuable nutrients, including dietary fiber.

Among other foods, which are the source of GL, is worth to pay attention to dairy and fried breaded products. Dairy products contains a small amount of carbohydrates and have a low GI. However, the high intake of dairy in the analyzed students diets caused, that they accounted 4.8% of the total dietary GL. Therefore, it is recommended to choose these dairy products that not contain added sugars eg. milk, natural yogurt, cottage cheese and hard cheese. Meat and fish not contain carbohydrates and therefore not influence on the GL of the diet. In this type of products a source of carbohydrates is a coated, both in the form of breadcrumb or flour, which is added during culinary processes. In the studied students diets the fried breaded products accounted 2.4% of the total dietary GL.

The female students diets which had higher GL were also characterized by higher content of dietary fiber. *Oh* et al. [21] showed that a higher content of dietary fiber in the high GL diets was associated with increased fruits intake. Indeed the role of dietary fiber in lowering postprandial serum glucose and decreasing insulin secretion is valuable [9]. *Schulze* et al. [26] found out that dietary fiber intake which source where cereal products was associated with lower incidences of type 2 diabetes in women. Furthermore European Society of Cardiology recommends adequate intake of dietary fiber because of its important role in cardiovascular disease prevention and reducing LDL cholesterol concentration in the blood serum [22]. The average daily fiber content in the students diets was consistent with the recommendations and amounted to 30.4 g. Approximately in 67% of women diets the dietary fiber intake was higher than 25 g/day, which was mainly due to the high consumption of vegetables and fruits.

Carbohydrates should be the main source of energy in the daily diet, however their amount and type have impact on the value of dietary GL, therefore, it is advisable to choose a low GI foods. At the second level from the bottom of Healthy Nutrition Pyramid [6] are whole grain cereals products. The low GI products of that group are: whole grain bread, oatmeal, buckwheat and barley, basmati rice or durum wheat pasta. *Lebiedzinska* [10] and *Ilow* [7] observed the improper habits of cereal products intake among students. Among those studying in Gdansk and Sopot, especially in men (approximately 74%) dominated the intake of wheat bread [10]. Although the female pharmacy students from Wroclaw consumed significantly more often whole grain bread than men, in both groups prevailed consumption of wheat bread and both wheat and whole grain bread (86.5% women, 92.3% men) [7].

According to food pyramid [6] it is recommended to consume as much as possible of vegetables and fruits daily, but they are also a source of carbohydrates. In the diets of studied women, these products provided 13% and 16% of carbohydrates. Most of the vegetables and fruits have low GI. Moreover these products are the source of dietary fiber, which reduces postprandial glycemia. In the study group the fruit and vegetable intake was high and amounted approximately to 758 g/day, what may be a result of the proper nutrition education among dietetics students.

In the daily diet should predominate the products contains slow-digestible carbohydrates. Whereas it is instead to limit the intake of sugar and products which may contain significant amounts of added sugars and could significantly increases the GL of diet, such as

sugar-sweetened beverages and carbonated beverages, sweets, pastries, sugar- sweetened yogurt or cream cheese. It should be recommended to choose their natural food substitutes.

CONCLUSIONS

Most of the analyzed diets were characterized by a medium or high value of GL, low energy intake from carbohydrates and proper content of dietary fiber.

The analysis shown that the greatest impact on increasing dietary GL had the increased consumption of products such as: sweets, cereals, juices and sweetened beverages. Therefore to decrease the value of dietary GL it is recommend to reduce intake of sweets and sweetened beverages, while among cereal products choose those with a low GI.

The lowering of GL diet should not be a result of the reduction of vegetables and fruits intake, most of which have low GI and are a source of soluble fiber affecting the reduction in postprandial serum glucose.

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Conflict of interest

The authors declare no conflict of interest.

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