Rocz Panstw Zakl Hig 2017;68(3):261-268

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ORIGINAL ARTICLE

# GLYCEMIC LOAD AND CARBOHYDRATES CONTENT IN THE DIETS OF CANCER PATIENTS

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## ABSTRACT

**Background:** Glycemic load (GL) is used to evaluate how various food products affect blood sugar level. According to some studies, high dietary GL may increase the risk of cancer development and recurrence.
**Objective:** The aim of the study was to assess dietary glycemic load and intake of carbohydrates derived from various food products by patients staying on an oncological ward.
**Material and methods:** The study group included 100 cancer patients aged 19-83 years (59.6 ± 11.3 years). GL, energy and nutrient intake was estimated based on the data from the Food Frequency Questionnaire (FFQ). The correlations between dietary GL and consumption of 18 groups of products were assessed.
**Results:** The average GL per 1000 kcal was 61.0 ± 8.6 g in the diets of men and 56.2 ± 9.5 g in the diets of women. High GL (>120 g) was observed in 76% of analyzed diets. The diets of men had higher GL, energy and sucrose content than the diets of women. Men, in comparison to women, consumed more refined grain products (144.1 ± 78.2 g vs. 95.5 ± 67.8 g), beverages (236.4 ± 344.7 g vs. 69.2 ± 173.0 g), honey and sugar (28.0 ± 22.2 g vs. 16.7 ± 18.0 g), dark chocolate (4.5 ± 4.5 g vs. 3.9 ± 6.7 g), sweets (66.1 ± 56.6 g vs. 38.8 ± 39.5 g) and soups (313.3 ± 105.3 g vs. 260.8 ± 160.3 g).
**Conclusions:** Analyzed diets were characterized by high GL and simple sugars content. Men consumed more refined and sweetened products than women. The improvement of knowledge about proper nutrition is needed in studied group of cancer patients.

**Key words:** *glycemic load, carbohydrates, sucrose, diet, cancer*

## STRESZCZENIE

**Wprowadzenie:** Ładunek glikemiczny (ŁG) jest stosowany w celu określenia wpływu spożycia poszczególnych produktów spożywczych na poziom glikemii we krwi. Według aktualnej wiedzy, wysoka wartość ŁG diety może zwiększać ryzyko rozwoju oraz nawrotu choroby nowotworowej.
**Cel**: Celem badania była ocena wartości ŁG oraz spożycia węglowodanów przez pacjentów przebywających na oddziale onkologicznym.
**Materiał i metody**: Grupa badana liczyła 100 pacjentów w wieku 19-83 lata (59.6 ± 11.3 g) ze zdiagnozowaną chorobą nowotworową. Wartość ŁG, wartość energetyczna oraz zawartość poszczególnych składników odżywczych w diecie zostały oszacowane na podstawie danych pochodzących z kwestionariusza częstotliwości spożycia żywności (FFQ). Zbadano korelacje pomiędzy ŁG i spożyciem produktów należących do 18 grup produktów spożywczych.
**Wyniki**: Średnia wartość ŁG w przeliczeniu na 1000 kcal diety wyniosła 61.0 ± 8.6 g w grupie mężczyzn i 56.2 ± 9.5 g w grupie kobiet. Zbyt wysoką wartość GL stwierdzono w 76% analizowanych diet. Diety mężczyzn charakteryzowały się wyższą wartością ŁG, podażą energii i zawartością sacharozy niż diety kobiet. Ponadto mężczyźni spożywali więcej rafinowanych produktów zbożowych (144.1 ± 78.2 g vs. 95.5 ± 67.8 g), napojów (236.4 ± 344.7 g vs. 69.2 ± 173.0 g), miodu i cukru (28.0 ± 22.2 g vs. 16.7 ± 18.0 g), gorzkiej czekolady (4.5 ± 4.5 g vs. 3.9 ± 6.7 g), słodyczy (66.1 ± 56.6 g vs. 38.8 ± 39.5 g) i zup (313.3 ± 105.3 g vs. 260.8 ± 160.3 g) niż kobiety.
**Wnioski**: Analizowane diety charakteryzowały się wysoką wartością ŁG oraz zawartością cukrów prostych. Badani mężczyźni spożywali więcej rafinowanych i słodzonych produktów spożywczych niż kobiety. Ponieważ nieodpowiednia dieta może zwiększać ryzyko rozwoju i nawrotu choroby, polepszenie stanu wiedzy na temat prawidłowego sposobu żywienia jest niezbędne w grupie pacjentów onkologicznie chorych.

**Słowa kluczowe**: *ładunek glikemiczny, węglowodany, sacharoza, dieta, choroba nowotworowa*

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## INTRODUCTION

Cancer is a leading cause of death worldwide and second one in Poland. In 2012, the most common cancers in group of men were: lung, colorectum and prostate cancer. In group of women, the most frequent cancers were: breast, colorectum and lung cancer. In both groups, the main cause of death was lung cancer [3].

According to the World Health Organization (WHO), in next 20 years, cancer-related mortality will increase by 70%. One of the most important causes of cancer is unhealthy diet: low intake of fruit, vegetables and whole grain products, as well as high intake of red and processed meat, salt, sweetened beverages, high-calorie foods and alcohol. Balanced diet, physical activity and normal body mass might have prevented from 5 to 34% of oral, throat, esophagus, stomach and colon cancer cases [15].

Patients during anticancer therapy should follow the recommendations for cancer prevention. Total intake of carbohydrates, recommended by the ACS (American Cancer Society), range from 45 to 65%. Specific guidelines for patients should depend on the localization of cancer, history of disease and individual preferences. If there are no contraindications, oncological patients should consume complex carbohydrates, such as wholegrain bread, groats, rice and pasta. Furthermore, they should increase the intake of fruit and vegetables, as a source of vitamins and minerals. Sweets and sugar are not recommended [18].

Particular food products may have high, medium or low glycemic index (GI). GI indicates the effect of food on blood glucose level and it varies depending on type and texture of food, cooking and processing technique, and also fat, protein and fiber content. Based on GI value, food products are classified as low (<55), medium (56-69) and high (above 70) GI. Cancer patients should choose products that have a low or medium GI [21].

Glycemic load (GL) is calculated based on GI, but it depends also on the quantity of eaten food and content of available carbohydrates. GI and GL of food are not always correlated and therefore GL is considered as practical illustration of GI. The GL of food can be classified as low (≤10 g), medium (11-19 g) and high (≥20 g) [21]. Although the results of conducted studies are not conclusive, it seems that high glycemic load as well as high sugars intake may affect the risk of cancer development and recurrence. Instead, high-fiber diet seems to have protective activity [6].

The aim of the study was to assess dietary glycemic load and intake of carbohydrates derived from various food products by patients staying on an oncological ward.

## MATERIALS AND METHODS

The study group included 100 patients (51 women and 49 men), aged 19-83 years (59.6 ± 11.3 years) from the Department of Clinical Oncology diagnosed with cancer.

The average energy value of diets, as well as dietary intake of nutrients over the previous year were assessed based on the data from the Food Frequency Questionnaire (FFQ). FFQ was created for Prospective Urban and Rural Epidemiological Study (PURE) and it was validated for the population of Lower Silesian Voivodeship [2]. The FFQ consists of 154 food items classified into 8 groups: milk and dairy products, fruits, vegetables, meat and eggs, cereal products, mixed dishes, beverages and snacks. Frequency of consumption was recorded in nine different categories (0-1/month, 1-3/month, 1/week, 2-4/week, 5-6/week, 1/day, 2-3/day, 4-5/day, >6/day) and the portion sizes were determined by using „Album of photographs of food products and dishes" [20].

Food intake in grams per day was calculated based on the consumption frequency and the given portion size. The average content of each nutrient in daily food rations (DFR) was estimated using database of the Food and Nutrition Institute in Warsaw, Poland [8].

Glycemic load of products and dishes was calculated based on their glycemic index and available carbohydrates content. GI values of individual foods were taken from international databases [4, 14] whereas GL of traditional polish dishes were calculated based on their composition [8].

In order to assess the correlation between food products consumption and GL value, food items from the FFQ were classified into following 18 groups: dairy, raw vegetables, cooked vegetables, fruits, raisins, fruit juices, sweetened beverages, unrefined grain products (wholegrain bread, groats, oats and pasta), refined grain products (white bread, white rolls, white rice, cornflakes), potatoes, crumbed food, mixed polish dishes, soups, nuts and seeds, milk chocolate, dark chocolate, sweets and honey and sugar. Grain products were classified as "refined" and "unrefined" based on their general nutritional value, GI value and dietary fiber content.

Body composition was measured by bioimpedance analysis (BIA), using Tanita BC 418-MA analyzer. Based on BMI values, patients were classified as normal weight (18.5-24.9 kg/m$^2$), overweight (25.0-29.9 kg/m$^2$) and obese (above 30.0 kg/m$^2$). Normal body fat percentage depend on age and vary between 21% and 36% for women and between 8% and 25% for men. Correct visceral adipose tissue level ranged from 1 to 13 [19].

Results of the study were analyzed statistically using Statistica 12.0 PL software. All statistical analyses were performed using the Kruskal-Wallis test, Mann-Whitney U test and Chi$^2$ test. The relationships between GL value and nutrients content in analyzed diets, as well as food group intake, were estimated using Pearson's linear correlation test. Correlation was considered strong if correlation coefficient R was above 0.6. The level of statistical significance for all analyses was set at $\alpha$=0.05.

The study was approved by the Bioethics Committee of Medical University of Wroclaw (No. KB-362/2014).

## RESULTS

Average body mass index (BMI) was 26.6 ± 5.2 kg/m$^2$ in the group of women and 27.7 ± 4.9 kg/m$^2$ in the group of men, thus it was excessively high in both groups. In the study population, 33% of women and 43% of men were overweight, while 29% of women and 27% of men were obese. Body fat percentage and visceral adipose tissue level were 32.3 ± 7.8% and 7.8 ± 3.2 in the group of women and 22.3 ± 8.0% and 12.6 ± 4.7 in the group of men, respectively. Body fat percentage was too high in 35% of women and 43% of men. Moreover, visceral adipose tissue level exceeded normal range in 6% of women and 43% of men (p<0.0001). Summary of characteristics of the study participants is presented in Table 1.

Table 1. The characteristics of the study group (X ± SD)

| Variables | Women (n=51) | Men (n=49) | p |
|---|---|---|---|
| Age [years] | 60.0 ± 9.5 | 61.0 ± 12.9 | Ns |
| BMI [kg/m$^2$] | 26.6 ± 5.2 | 27.7 ± 4.9 | Ns |
| Body fat [%] | 32.3 ± 7.8 | 22.3 ± 8.0 | <0.0001 |
| Visceral adipose tissue level | 7.8 ± 3.2 | 12.6 ± 4.7 | <0.0001 |

X ± SD - average ± standard deviation, p - statistical significance, BMI - body mass index, Ns - no statistically significant differences between gender groups

Table 2 presents the average energy intake, GL and content of carbohydrates, fats and proteins in the diets of respondents. The average energy intake was significantly higher in the diets of men compared to women (3150.8 ± 1129.5 kcal vs. 2544.6 ± 813.8 kcal). Due to the fact, that higher energy intake is usually associated with the increased macronutrients content in DFR, the intake of carbohydrates, fats and protein in the diets of the study group was calculated per 1000 kcal. High GL (>120 g) was observed in 76%, while medium (80-120 g) and low GL (<80 g) in 19% and 5% of analyzed diets, respectively. Percentage of diets with too high GL was significantly greater in the group of men compared to women. The average value of GL per 1000 kcal was also significantly higher in the diets of men (61.0 ± 8.6 g) compared to women (56.2 ± 9.5 g). Moreover, men consumed significantly more sucrose (29.3 ± 12.5 vs. 24.0 ± 10.1 g/1000 kcal), but less fats (43.3 ± 6.9 vs. 46.9 ± 6.7 g/1000 kcal) and dietary fiber (10.3 ± 2.7 vs. 12.5 ± 3.3 g/1000 kcal) than women.

Correlation between dietary GL per 1000 kcal, energy intake and content of carbohydrates, proteins and fats per 1000 kcal, described by the Pearson's correlation coefficients, is shown in Table 3. Strong positive correlation was found between GL per 1000 kcal and carbohydrates content (r=0.85), whereas strong negative correlation was observed between GL per 1000 kcal and fats (r=-0.75). Among men, dietary GL per 1000 kcal was also strongly correlated with sucrose content (r=0.65), while among women a strong correlation (r=0.60) between dietary GL per 1000 kcal and starch was observed. Overall, higher protein intake reduced dietary GL value (r=-0.32).

The analyzed diets of men contained significantly more sweetened beverages (236.4 ± 344.7 g vs. 69.2 ± 173.0 g), honey and sugar (28.0 ± 22.2 g vs. 16.7 ± 18.0 g), dark chocolate (4.5 ± 4.5 g vs. 3.9 ± 6.7 g), sweets (66.1 ± 56.6 g vs. 38.8 ± 39.5 g) and soups (313.3 ± 105.3 g vs. 260.8 ± 160.3 g), in comparison with the diets of women. Moreover, in spite of similar intake of unrefined grain products in both groups, men consumed significantly more refined grain products than women (144.1 ± 78.2 g vs. 95.5 ± 67.8 g). Also the energy intake from all listed products was significantly lower in group of women compared to men. It is worth mentioning, that although the consumption of unrefined grains in group of women was greater than the consumption of refined grains, the latter provided more energy. The main source of energy in analyzed diets were dairy, refined grain products and, in group of men, sweets. All food group intake and their energy values are presented in Table 4.

Average carbohydrates, sucrose and starch content in groups of food products, as well as their GL value are presented in Table 5. The main sources of carbohydrates in analyzed diets were refined grain products, fruits, sweets (in the group of men) and unrefined grain products (in the group of women). Statically significant difference in the intake of carbohydrates was found between gender groups with reference to refined grain products, dairy, sweetened beverages, honey and sugar, dark chocolate and soups. Moreover, all listed products except dairy provided significantly more sucrose in the diets of men compared to women. However, the main sources of sucrose in the diets of women were fruits (12.0 ± 6.3 g), sweets (10.3 ± 11.3 g) and fruit juices (9.8 ± 14.4 g), while in the diets of men sweetened beverages (21.8 ± 33.7 g), sweets

(17.7 ± 18.3 g), and honey and sugar (15.0 ± 17.4 g). Grain products provided the most starch in the DFR of both groups. The diets of men were significantly richer in starch derived from refined grain products, sweets and soups in comparison with the diets of women. The highest GL in the diets of men provided refined grain products (49.7 ± 27.4 g), sweets (23.7 ± 22.5 g) and honey and sugar (15.8 ± 12.7 g), while in the diets of women refined grain products (30.6 ± 23.2 g), unrefined grain products (16.1 ± 14.4 g) and fruits (15.0 ± 7.2 g).

Table 6 shows the correlation between dietary GL per 1000 kcal and food group intake, described by the Pearson's correlation coefficients. In analyzed diets overall the most significant correlation was found with reference to refined grain products (r=0.36) and sweetened beverages (r=0.31). In the diets of women correlations with the consumption of refined grain products (r=0.46) and honey and sugar (r=0.32) were observed, while in the diets of men with sweetened beverage intake (r=0.41). Negative correlation was found for nuts and seeds (r=-0.28) content in the DFR of women and for cooked and raw vegetables (r=-0.32 and r=-0.31, respectively) content in the DFR of men.

Table 2. Energy intake, glycemic load and carbohydrates, protein and fat content per 1000 kcal in analyzed diets of women and men (X ± SD)

| Variables | Women (n=51) | Men (n=49) | p |
|---|---|---|---|
| Energy [kcal] | 2544.6 ± 813.8 | 3150.8 ± 1129.5 | 0.0032 |
| Glycemic load | 143.4 ± 49.9 | 189.3 ± 64.5 | 0.0004 |
| Glycemic load / 1000 kcal | 56.2 ± 9.5 | 61.0 ± 8.6 | 0.0105 |
| Carbohydrates [% of energy] | 42.1 ± 6.2 | 44.4 ± 5.8 | Ns |
| Protein [% of energy] | 15.4 ± 3.1 | 15.2 ± 2.7 | Ns |
| Fats [% of energy] | 42.1 ± 6.0 | 39.0 ± 6.2 | 0.0149 |
| Carbohydrates [g/1000 kcal] | 117.9 ±16.8 | 121.2 ± 15.6 | Ns |
| Sucrose [g/1000 kcal] | 24.0 ± 10.1 | 29.3 ± 12.5 | 0.0177 |
| Starch [g/1000 kcal] | 48.9 ± 11.6 | 51.2 ± 9.0 | Ns |
| Dietary fiber [1000 kcal] | 12.5 ± 3.3 | 10.3 ± 2.7 | 0.0005 |
| Protein [g/1000 kcal] | 38.5 ± 7.9 | 37.9 ± 6,6 | Ns |
| Fats [g/1000 kcal] | 46.9 ± 6.7 | 43.3 ± 6.9 | 0.0149 |

X ± SD - average ± standard deviation, p - statistical significance, Ns - no statistically significant differences between gender groups

Table 3. Correlation between dietary glycemic load per 1000 kcal and energy and macronutrient intake in analyzed diets, described by the Pearson correlation coefficient

| Variables | Overall (n=100) | | Women (n=51) | | Men (n=49) | |
|---|---|---|---|---|---|---|
| | R | *p* | R | *p* | R | *p* |
| Carbohydrates [g/1000 kcal] | 0.85 | <0.001 | 0.85 | <0.001 | 0.87 | <0.001 |
| Sucrose [g/1000 kcal] | 0.58 | <0.001 | 0.48 | <0.001 | 0.65 | <0.001 |
| Starch [g/1000 kcal] | 0.57 | <0.001 | 0.60 | <0.001 | 0.51 | <0.001 |
| Dietary fiber [g/1000 kcal] | -0.00 | Ns | 0.07 | Ns | 0.14 | Ns |
| Protein [g/1000 kcal] | -0.32 | 0.001 | -0.44 | 0.001 | -0.15 | Ns |
| Fats [g/1000 kcal] | -0.75 | <0.001 | -0.72 | <0.001 | -0.77 | <0.001 |

R - Pearson's correlation coefficient, p - statistical significance, Ns - no statistically significant correlation

Table 4. Average daily intake of particular groups of food products and their energy value (X ± SD)

| Products | Women (n=51) | | Men (n=49) | |
|---|---|---|---|---|
| | Intake [g/day] | Energy [kcal/day] | Intake [g/day] | Energy [kcal/day] |
| Unrefined grain products | 124.9 ± 118.4 | 161.9 ± 136.2 | 126.6 ± 114.2 | 143.6 ± 136.6 |
| Refined grain products | 95.5 ± 67.8 *a* | 219.8 ± 164.4 *a* | 144.1 ± 78.2 | 352.3 ± 194.1 |
| Potatoes | 97.8 ± 92.4 | 105.4 ± 100.3 | 103.1 ± 58.8 | 116.2 ± 68.1 |
| Fruits | 328.4 ± 167.1 | 162.0 ± 77.0 | 321.8 ± 176.0 | 158.5 ± 87.8 |
| Raw vegetables | 237.1 ± 146.7 | 64.4 ± 41.3 | 194.1 ± 128.9 | 58.3 ± 40.3 |
| Cooked vegetables | 144.1 ± 98.7 | 94.7 ± 48.3 | 126.9 ± 69.6 | 95.1 ± 45.8 |
| Dairy | 419.0 ± 290.1 | 394.7 ± 259.0 | 546.5 ± 369.0 | 448.0 ± 262.7 |
| Nuts and seeds | 23.2 ± 42.8 | 132.7 ± 243.0 | 13.4 ± 17.7 | 76.1 ± 99.8 |
| Fruit juices | 182.0 ± 224.2 | 83.2 ± 104.8 | 159.5 ± 175.2 | 72.1 ± 80.0 |
| Sweetened beverages | 69.2 ± 173.0 *a* | 24.1 ± 70.6 *a* | 236.4 ± 344.7 | 95.6 ± 147.8 |
| Honey and sugar | 16.7 ± 18.0 *a* | 61.8 ± 69.9 *a* | 28.0 ± 22.2 | 102.6 ± 81.0 |
| Raisins | 8.7 ± 17.1 | 24.1 ± 47.4 | 4.0 ± 7.1 | 11.1 ± 19.7 |
| Milk chocolate | 4.9 ± 18.5 | 26.9 ± 101.6 | 3.9 ± 7.5 | 21.5 ± 41.2 |
| Dark chocolate | 3.9 ± 6.7 *a* | 21.3 ± 37.0 *a* | 4.5 ± 4.5 | 24.8 ± 24.9 |
| Sweets | 38.8 ± 39.5 *a* | 143.1 ± 149.9 *a* | 66.1 ± 56.6 | 240.6 ± 210.2 |
| Soups | 260.8 ± 160.3 *a* | 103.9 ± 56.6 *a* | 313.3 ± 105.3 | 128.8 ± 46.3 |
| Crumbed food | 23.5 ± 15.1 | 66.0 ± 42.3 | 33.7 ± 24.2 | 97.0 ± 78.1 |
| Mixed polish dishes | 36.7 ± 26.0 | 56.4 ± 42.7 | 37.3 ± 24.2 | 55.9 ± 37.1 |

SD - standard deviation, *a* - means statistically significant difference between group of women and men

Table 5. Average carbohydrates, sucrose and starch content and glycemic load (GL) of particular groups of food products (X ± SD)

| Products | Women (n=51) | | | | Men (n=49) | | | |
|---|---|---|---|---|---|---|---|---|
| | Carbohydrates [g] | Sucrose [g] | Starch [g] | GL [g] | Carbohydrates [g] | Sucrose [g] | Starch [g] | GL [g] |
| Unrefined grain products | 34.2 ± 29.8 | 0.9 ± 0.9 | 25.5 ± 21.7 | 16.1 ± 14.4 | 28.7 ± 30.2 | 0.7 ± 0.9 | 21.7 ± 22.1 | 13.4 ± 14.4 |
| Refined grain products | 47.7 ± 35.8 *a* | 1.1 ± 0.9 *a* | 41.7 ± 31.3 *a* | 30.6 ± 23.2 *a* | 76.2 ± 41.5 | 2.0 ± 1.2 | 66.4 ± 36.8 | 49.7 ± 27.4 |
| Potatoes | 18.7 ± 17.6 | 0.5 ± 0.5 | 15.2 ± 14.7 | 11.1 ± 10.5 | 20.2 ± 11.6 | 0.5 ± 0.3 | 15.7 ± 9.1 | 11.8 ± 6.8 |
| Fruits | 42.7 ± 20.4 | 12.0 ± 6.3 | 1.2 ± 1.0 | 15.0 ± 7.2 | 41.6 ± 23.1 | 12.6 ± 7.6 | 1.2 ± 1.0 | 14.4 ± 8.2 |
| Raw vegetables | 13.6 ± 9.3 | 1.9 ± 1.6 | 1.2 ± 1.4 | 3.6 ± 2.5 | 12.0 ± 8.6 | 1.8 ± 1.5 | 1.4 ± 1.7 | 3.4 ± 2.6 |
| Cooked vegetables | 11.6 ± 7.1 | 2.9 ± 2.2 | 2.8 ± 2.4 | 4.0 ± 2.3 | 11.8 ± 6.0 | 3.4 ± 2.5 | 2.8 ± 1.7 | 4.2 ± 2.3 |
| Dairy | 21.0 ± 14.9 *a* | 3.2 ± 3.0 | 0.0 ± 0.0 | 6.8 ± 4.9 *a* | 28.5 ± 18.4 | 4.5 ± 5.1 | 0.0 ± 0.0 | 9.5 ± 6.3 |
| Nuts and seeds | 4.7 ± 8.3 | 1.2 ± 2.4 | 1.6 ± 2.6 | 0.5 ± 0.8 | 2.7 ± 3.6 | 0.6 ± 0.9 | 1.1 ± 1.4 | 0.3 ± 0.4 |
| Fruit juices | 20.1 ± 25.3 | 9.8 ± 14.4 | 0.1 ± 0.2 | 9.1 ± 11.7 | 17.3 ± 19.2 | 7.7 ± 10.8 | 0.1 ± 0.2 | 7.9 ± 8.7 |
| Sweetened beverages | 5.9 ± 17.2 *a* | 5.5 ± 15.9 *a* | 0.0 ± 0.0 | 3.4 ± 10.0 *a* | 23.4 ± 36.2 | 21.8 ± 33.7 | 0.0 ± 0.0 | 13.5 ± 21.0 |
| Honey and sugar | 15.2 ± 17.2 *a* | 9.4 ± 16.4 *a* | 0.0 ± 0.0 | 9.6 ± 11.4 | 25.2 ± 19.9 | 15.0 ± 17.4 | 0.0 ± 0.0 | 15.8 ± 12.7 |
| Raisins | 6.2 ± 12.2 | 0.1 ± 0.2 | 0.0 ± 0.0 | 3.6 ± 7.1 | 2.8 ± 5.1 | 0.0 ± 0.1 | 0.0 ± 0.0 | 1.7 ± 2.9 |
| Milk chocolate | 2.7 ± 10.1 | 1.8 ± 6.8 | 0.1 ± 0.5 | 1.1 ± 4.3 | 2.1 ± 4.1 | 1.4 ± 2.8 | 0.1 ± 0.2 | 0.9 ± 1.7 |
| Dark chocolate | 2.1 ± 3.7 *a* | 1.4 ± 2.5 *a* | 0.1 ± 0.2 *a* | 0.9 ± 1.6 *a* | 2.5 ± 2.5 | 1.7 ± 1.7 | 0.1 ± 0.1 | 1.0 ± 1.1 |
| Sweets | 22.4 ± 23.4 *a* | 10.3 ± 11.3 *a* | 10.4 ± 11.7 *a* | 13.1 ± 14.0 *a* | 39.8 ± 36.4 | 17.7 ± 18.3 | 19.3 ± 23.7 | 23.7 ± 22.5 |
| Soups | 17.0 ± 9.3 *a* | 1.2 ± 0.7 *a* | 11.5 ± 6.0 *a* | 7.5 ± 4.0 *a* | 20.0 ± 7.8 | 1.5 ± 0.5 | 14.4 ± 5.6 | 9.4 ± 3.4 |
| Crumbed food | 2.4 ± 1.6 | 0.0 ± 0.0 | 2.2 ± 1.4 | 1.6 ± 1.1 | 3.3 ± 2.8 | 0.0 ± 0.0 | 3.1 ± 2.6 | 2.2 ± 1.9 |
| Mixed polish dishes | 6.8 ± 5.4 | 0.1 ± 0.1 | 5.7 ± 4.7 | 4.0 ± 3.3 | 6.4 ± 4.9 | 0.1 ± 0.1 | 5.3 ± 4.2 | 3.7 ± 3.1 |

GL – glycemic load, *a* - means statistically significant difference between group of women and men

Table 6. Correlation between dietary glycemic load per 1000 kcal and intake (g/day) of particular groups of food products, described by the Pearson correlation coefficient

| Products | Overall (n=100) | | Women (n=51) | | Men (n=49) | |
|---|---|---|---|---|---|---|
| | R | *p* | R | *p* | R | *P* |
| Unrefined grain products | -0.05 | Ns | 0.02 | Ns | -0.15 | Ns |
| Refined grain products | 0.36 | <0.001 | 0.46 | 0.001 | 0.16 | Ns |
| Potatoes | 0.08 | Ns | 0.24 | Ns | -0.22 | Ns |
| Fruits | 0.06 | Ns | 0.22 | Ns | -0.10 | Ns |
| Raw vegetables | -0.22 | 0.028 | -0.09 | Ns | -0.31 | 0.028 |
| Cooked vegetables | -0.16 | Ns | -0.03 | Ns | -0.32 | 0.027 |
| Dairy | -0.09 | Ns | -0.08 | Ns | -0.21 | Ns |
| Nuts and seeds | -0.29 | 0.003 | -0.28 | 0.049 | -0.09 | Ns |
| Fruit juices | -0.02 | Ns | -0.03 | Ns | 0.03 | Ns |
| Sweetened beverages | 0.31 | 0.002 | 0.04 | Ns | 0.41 | 0.004 |
| Honey and sugar | 0.21 | 0.036 | 0.32 | 0.022 | -0.00 | Ns |
| Raisins | 0.02 | Ns | 0.11 | Ns | -0.04 | Ns |
| Milk chocolate | 0.15 | Ns | 0.25 | Ns | -0.05 | Ns |
| Dark chocolate | -0.03 | Ns | -0.12 | Ns | 0.09 | Ns |
| Sweets | 0.17 | Ns | 0.26 | Ns | -0.01 | Ns |
| Soups | 0.10 | Ns | 0.04 | Ns | 0.08 | Ns |
| Crumbed food | -0.02 | Ns | 0.12 | Ns | -0.22 | Ns |
| Mixed polish dishes | -0.07 | Ns | 0.06 | Ns | -0.23 | Ns |

R - Pearson's correlation coefficient, p - statistical significance, Ns - no statistically significant correlation

## DISCUSSION

The diet of study participants was not like diet recommended in cancer therapy. It was characterized by too high GL, increased content of simple sugars and improper macronutrients proportions. In both gender groups, carbohydrates content in the diet was lower than recommended [18]. Significant differences in eating habits between the groups of men and women were observed. Compared to women, men consumed more sweetened products and refined grains. They also had a lower intake of dietary fiber and fats.

The majority of patients were overweight or obese and most of them had excess body fat content and visceral adipose tissue level. According to The International Agency for Research on Cancer (IARC), there is a strong relationship between body fatness and cancer. At present, sufficient evidence for a preventive effect of adequate BMI exists with reference to 13 cancer types, including esophagus, colon and rectum, pancreas and postmenopausal breast cancer [10].

High dietary GL observed in the presented study resulted from excessive intake of refined grain products (white bread, white rolls, white rice and cornflakes), sweets, honey and sugar, as well as a relatively high consumption of unrefined grain products and fruits. In spite of comparable amount of unrefined and refined grain products in the diets of men, the latter provided much more energy and had significantly higher GL than unrefined.

The results of studies concerning the influence of high GL on cancer development are not conclusive. However, *Hu* et al. [7] conducted a study involving 5039 oncological patients and observed, that high dietary GL increased the risk of developing colon, rectum and pancreas cancer. Consumption of food products with high GI was found to increase the risk of prostate cancer. In a meta-analysis of 39 studies, performed by *Gnagnarella* et al. [6], positive correlation between high dietary GL or high GI of consumed products and uterus and colon cancer development was observed. Furthermore, higher GL and carbohydrate intake were significantly associated with an increased risk of cancer recurrence and mortality in group of stage III colon cancer patients, especially those with BMI ≥ 25 kg/m$^2$ [13].

Analyzed diets were low-carbohydrate (<45% of energy), but they contained large amounts of simple sugars. The main sources of sucrose in analyzed diets of men were sweetened beverages. *Meinhold* et al. [11], in The Prostate, Lung, Colorectal, and Ovarian Cancer Screening Trial, did not found any correlations between sucrose and fructose intake and pancreas cancer. ACS guidelines also establish that high intake of sugar has not been shown to increase the risk of cancer progression [18]. Nonetheless, in some studies,

high intake of sweetened beverages was associated with increased risk of development of pancreas cancer [9], as well as increased recurrence and mortality rate in group of patients with colon cancer [5].

Besides, frequent consumption of sweetened beverages, sweets and sugar may lead to hyperglycemia and hyperinsulinemia, as well as diabetes mellitus development. Insulin increases the insulin-like growth factors (IGF) synthesis in the liver. High level of IGF in blood may enhance the risk of prostate and breast cancer development and cause resistance to treatment with anticancer drugs [17, 22].

*Pisani* [16] found, that high blood glucose, insulin, peptide C and glycated hemoglobin level was associated with higher risk of colon, rectum, pancreas, breast and endometrium cancer development. *Ben* et al. [1] performed a meta-analysis of 35 cohort studies and demonstrated that patients with diabetes mellitus had higher risk of pancreas cancer development.

Overall, the average diet of the study participants was similar to "Western diet". Improper eating habits, especially in the group of men, included consumption of processed and high energy density food products. Refined grains, sweets and sweetened beverages contain significantly less essential nutrients and dietary fiber than unprocessed food, such as whole grains, fruits and vegetables. Although in some cases high fiber foods are not recommended due to digestive problems, large consumption of high-fat and high-sugar products in the studied group indicates that the reason of avoiding whole grains was not associated with gastrointestinal disorders.

High intake of sweets and sweetened beverages is considered as a risk factor not only for cancer, but also for other lifestyle diseases, such as heart diseases, hypertension or diabetes mellitus. *Meyerhardt* et al. [12] observed that the Western dietary pattern in remission of colon cancer was associated with higher risk of recurrence and death in comparison with "healthy" dietary pattern, rich in fruits and vegetables.

Eliminating sweetened beverages, honey and sugar from the diet of men could reduce their dietary GL even by 15%. In addition, it was estimated that changing refined into unrefined grain products, without reducing their amount, would have cut dietary GL in the group of men to less than 126 g. Moreover, higher intake of vegetables, nuts and seeds, which were inversely correlated with GL per 1000 kcal, would increase many vitamins and minerals content in the diet.

Above-mentioned changes in dietary habits are simple to implement with the participation of qualified dietitian. According to current findings, low dietary GL and sugar avoidance may improve carbohydrates metabolism and protect from cancer development and recurrence. Enhancement of knowledge about relationships between diet and cancer is thus needed in order to change eating behaviors among the oncological patients.

## CONCLUSIONS

Although analyzed diets did not contain a lot of carbohydrates, they had high GL due to the excessive consumption of high GI products. The group of men was found to have higher energy intake, dietary GL value and content of sucrose in the diet in comparison with the group of women. Moreover, men consumed more products considered as unhealthy, such as sweetened beverages, sweets, honey and sugar, white bread and rolls, white rice and cornflakes.

High dietary GL and high intake of sucrose causes considerable changes in blood glucose level, what leads to hyperglycemia and hyperinsulinemia. According to current knowledge, improper diet and, in effect, abnormal carbohydrates metabolism, may increase the risk of cancer development, as well as cause higher mortality rate among cancer patients.

Elimination of sweets, sweetened beverages and products containing white flour and greater consumption of raw and cooked vegetables, nuts and seeds, unsweetened beverages and whole grain products is recommended for the study participants in order to provide required nutritional status and dietary nutrient intake.

**Conflict of interest**

*The authors declare no conflict of interest.*

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Received: 22.12.2016
Accepted: 07.04.2017