ORIGINAL ARTICLE

# STUDIES ON THE QUALITY OF NUTRITION IN WOMEN WITH POLYCYSTIC OVARY SYNDROME (PCOS)

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## ABSTRACT

**Background.** Polycystic ovary syndrome (PCOS) manifests itself with various symptoms, therefore it interests representatives of many medical specializations: general practitioners, gynecologists, endocrinologists, dermatologists, cardiologists and those who deal with metabolic disorders, such as dieticians.

Objective. The aim of this study was perform the qualitative assessment of components of diets of women with PCOS as one of the major factor contributing to the disease.

**Material and Methods.** The study was performed on 54 women of childbearing age with PCOS diagnosed according to on the Rotterdam criteria. Qualitative assessment of the diets on the basis of 216 menus was performed based on the analysis of 3-day food diaries and food records taken from the last 24-hour dietary interview. Diets quality assessment was made using three types of point tests: *Szewczyński's* Diets' classification (SDC), *Bielińska's* Test with *Kulesza's* modification (BT-K), Healthy Diet Indicator (HDI).

**Results.** Average waist-hip ratio (WHR) and body mass index (BMI) was above the standard 0.91± 0.08 and 29.16 ± 5.8 kg/m2. Qualitative analysis performed with point tests SDC, BT-K and HDI revealed that the majority of the diets were composed inappropriately, containing many mistakes. Statistically significant correlations (*Pearson's*) were determined between HDI test and the body weight and BMI. When analyzing the type of the meals also the correlations (*Spearman's*) between BMI and BMI category in BT-K test.

**Conclusions.** Mistakes in diets of women with PCOS are the cause of metabolic disorders related to improper function of ovaries. Native test BT-K seems to be a better method then test SDC and probably HDI of assessing diet in women with PCOS from Poland.

**Key words:** *polycystic ovary syndrome, PCOS, nutrition, diet, quality assessment of nutrition*

## STRESZCZENIE

**Wprowadzenie.** Zespół policystycznych jajników (PCOS) manifestuje się wieloma objawami, dlatego cieszy się coraz większym zainteresowaniem lekarzy: ginekologów, endokrynologów, dermatologów, kardiologów oraz osób z zespołem metabolicznym związanych, takich jak dietetycy.

**Cel.** Celem pracy było przeprowadzanie oceny jakościowej diet kobiet z PCOS i zweryfikowanie tezy, że żywienie jest jednym z głównych czynników przyczyniających się do tej choroby.

**Materiał i metody.** Badaniami objęto 54 kobiety w wieku rozrodczym z PCOS zdiagnozowanych według kryteriów Rotterdamskich. Jakościową ocenę diety przeprowadzono w oparciu o 216 jadłospisów zebranych metodą wywiadu o spożyciu z ostatnich 24 godzin oraz dzienniczka żywieniowego z 3 dni. Ocenę jakości diety wykonano przy użyciu trzech rodzajów testów punktowych: *Szewczyńskiego* (SDC), *Bielińskiej* z modyfikacją *Kuleszy* (BT-K) oraz Indeksu Zdrowej Diety (HDI) wg WHO.

**Wyniki:** Średnie wartości wskaźnika talia-biodro (WHR) i wskaźnika masy ciała (BMI) kobiet było powyżej wartości referencyjnych i wynosiło odpowiednio 0.91±0.08 oraz 29.16± 5.8 kg/m². Analiza jakościowa przeprowadzona testami punktowymi wykazała, że większość diet została skomponowane w niewłaściwy sposób i zawierała liczne błędy. Stwierdzono statystycznie istotną korelację *Pearsona* między testem HDI i masą ciała oraz BMI. Z analizy rodzaju posiłków (korelacja *Spearmana*) wykazano istotną zależność pomiędzy BMI ogółem a strukturą BMI w teście BT-K.

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**Wnioski.** Błędy żywieniowe popełniane prze kobiety z PCOS, są przyczyną zaburzeń metabolicznych związanych z nieprawidłowym funkcjonowaniem jajników. Rodzimy test punktowy oceny jakości żywienia BT-K, wydaje się być lepszym narzędziem niż test SDC i prawdopodobnie HDI w ocenie jakości diety kobiet z PCOS z Polski.

*Słowa kluczowe: zespół policystycznych jajników, PCOS, żywienie, dieta, ocena jakościowa żywienia*

## INTRODUCTION

Improper dietary habits are often noticed among the women with PCO syndrome, and those are related to the intake of food of low nutritional value and high energy content, which seems to be in accordance with the concept of insulin-dependent cause of PCOS. As reported in the literature, insulin increases the production of androgens, affecting ovarian theca cells, leading to further increase of hormones' concentration [18].

Moreover, insulin also indirectly affects steroid genesis via insulin-like growth factor (IGF-1). Its elevated concentration in follicle fluid contributes, together with insulin, to increased androgenesis, as well as to premature ovarian follicle atresia. The reciprocal effect of insulin-like IGF-1 strengthens the above mentioned symptoms [8]. The studies also showed that the elevated concentration of testosterone in blood of women with PCOS is also affected by the decreased level of SHBG (sex hormone binding globulin), which is also modulated by insulin [16].

Women eating habits are determined, among others, by the habits taken from family home, economic status, culture (religion, tradition), education, origin and age. Metabolic disorders, occurring during PCOS, can lead to the development of diabetes, dyslipidemia or cardio-vascular diseases (CVD). It should be stressed that in case of PCOS the risk of type 2 diabetes is 3-7 times higher [20]. Therefore using the diet with low glycemic index, rich in dietary fibre, with low content of saturated fatty acids (SFA) and cholesterol is the best way to fight with PCOS. Other studies show that increased consumption of plant protein lowers the risk of infertility caused by ovulation disorders. At the same time no negative effect on fertility was determined after the consumption of fish and eggs proteins [5]. As shown in the studies of *Douglas* et al. [7], the increased consumption of dietary fibre by 10g, in group of women aged 32 and above, lowered the risk of fertility disorders due to ovulation disorders by 44%. Proper intake of antioxidants in a diet, including vitamins C and E, β-carotene, zinc, copper, selenium and coenzyme Q10, protects against free radicals (lipid peroxides). The negative effect of free radicals on the organism is based on oxidative stress, which leads to the damage of, among others, cellular membranes [19].

Among the antioxidants used in PCOS treatment the commonly mentioned are coenzyme Q10 (ubiquinone), having anti-sclerotic activity [17], and folic acid, as one of the coenzymes, which takes part in homocysteine metabolism. The sources of folic acid are green vegetables, dry legumes, wholegrain products, liver and eggs. Numerous dietary mistakes often cause in women with PCOS the extensive development of fatty tissue, especially the visceral one, and difficulties with body mass reduction. It is known, that the development of the disease is influenced by genetic, hormonal and environmental factors. However, balanced diet, increased physical activity and maintenance of proper BMI contribute to lower risk of infertility in women [4].

The effect of diet quality on the occurrence and severity of the disease inter alia, cancer breast , lung cancer bone and soft tissue cancer investigated [21]. Interestingly, *Ćwiek-Ludwicka* and *Ludwicki* [6] also note the influence food contact materials (FCMs) on the hormonal system through endocrine disrupting chemical substances (EDCs).

The studies on the quality of food consumed by women with PCOS have not been previously conducted, thus the determination of dietary mistakes is an important factor in the studies on the development of PCOS. Studies on the quantitative assessment of nutrition patients with PCOS have previously shown [22].

## MATERIAL AND METHODS

*Test group*

Women taking part in the study were diagnosed in the Clinic of Gynecology and Urogynecology of Pomeranian Medical University (PUM) in Independent Public Clinic Hospital No. 1 in Police. PCOS was diagnosed according to Rotterdam's criteria, which require the diagnosis of 2 out of 3 following criteria: rare ovulations or lack of thereof, and/or biochemical symptoms of hyperandrogenism, and/or image of polycystic ovaries in USG (polycystic ovaries morphology in transvaginal USG - the presence of 12 follicles or more in one or both ovaries, and/or increased volume of ovary >10ml). The image was obtained using Ultrasound Voluson 730 (GE, Switzerland).

The research has been approved by the Bioethical Commission PUM, No. KB-0012/134/12, with the annex to the permission No. KB-0012/36/14.

*Assessment of nutritional status*

To assess nutritional status of the patients the following anthropometric tests were used: body weight (with 0.1 kg accuracy), body height, waist

circumference and hip circumference - using anthropometric measuring tape (with accuracy 0.5 cm). On the basis of those data the Body Mass Index (BMI) was calculated and the type of body built (WHR - Waist Hip Ratio) was determined [25].

*Qualitative dietary assessment*

The information on the consumption of products and meals were collected using two methods: food records method (food diaries) from 3 days and one-day food record (interview) from the last 24h. Records from the food diary and the interview included: ingredients, quantity, mode of preparation and time of consumption of every meal. Menus were taken from two weekdays (Thursday and Friday) and two weekend days (Saturday and Sunday). Altogether 216 menus from 54 women with PCOS were analysed. The sizes of consumed portions were determined according to the "Album of photographs of food products and dishes" of the National Institute of Food and Nutrition [23]. The qualitative assessment of diets was performed using three types of point tests: two nationally recognized tests, recommended by the Polish Food and Nutrition Institute [9] - *Szewczyński's* diets' classification (SDC) and *Bielińska's* test with *Kulesza's* et al. modification (BT-K), as well as Healthy Diet Indicator (HDI) according to joint WHO/FAO [15].

*Statistical analysis*

In order to assess the correlation between the quality of the diets of tested women and their nutritional status, *Pearson's* and *Spearman's* correlation coefficients were calculated, together with significance tests for each two dependent and independent variables. For qualitative attributes *Pearson's* correlation coefficient was calculated, whereas for qualitative variables - Spearman's correlation was used. In the test the following independent variables (anthropometric parameters) were determined:

- age [years] - quantitative variable;
- body weight [kg] - quantitative variable;
- waist circumference [cm] - quantitative variable;
- hip circumference [cm] - quantitative variable;
- BMI [kg/m$^2$] - quantitative variable;
- BMI according to the category - qualitative variable;
- WHR [cm/cm] - quantitative variable;
- WHR according to the category - qualitative variable.

Also the following dependent variables, i.e. qualitative parameters of dietary assessment, were determined:

➢ *Szewczyński's* diets' classification (SDC) - average score - quantitative variable;

➢ *Szewczyński's* diets' classification (SDC) - according to meal class I-IV - qualitative variable;

➢ *Bielińska's* test with *Kulesza's* et al. modification (BT-K) - average score - quantitative variable;

➢ *Bielińska's* test with *Kulesza's* et al. modification (BT-K) - meals assessment according to point scale - qualitative variable;

➢ Healthy Diet Indicator (HDI) - average score - quantitative variable.

The results of performed tests were presented in form of mean values, standard deviations and percentage calculations. Interpretation of results obtained for qualitative dietary assessment was presented in form of distance distribution (median, first and third quartile, and minimal and maximal value) of dependent variables expressed as the average score (received points). Statistical analyses were performed using STATISTICA 10.0 (Statsoft, Tulsa, Oklahoma, USA).

## RESULTS

Nutritional status: In the group of 54 women with PCOS the average age of patients was 26.31 ± 5.52, and the average body weight was 80.98 ± 16.06 kg. The average BMI value was 29.16 ± 5.8 kg/m$^2$. The characteristics of anthropometric parameters of tested women are presented in Table 1.

Table 1. Anthropometric characteristics of tested group

| Parameter | $\bar{x}$ | SD |
|---|---|---|
| Age [years] | 26.31 | 5.52 |
| Waist circumference [cm] | 99.18 | 14.82 |
| Hip circumference [cm] | 108.45 | 9.39 |
| Body weight [kg] | 80.98 | 16.06 |
| Height [m] | 1.67 | 0.06 |
| BMI - Body Mass Index[kg/m$^2$] | 29.16 | 5.8 |
| WHR- Waist-Hip Ratio [cm/cm] | 0.91 | 0.08 |

Table 2. Average classification of diets of test group with PCOS according to selected diet quality indexes

| Diet quality index | $\bar{x}$ | minimum | maximum | SD |
|---|---|---|---|---|
| SDC (classes I-IV/ 1-4 points) | 2.55 | 1 | 4 | 0.96 |
| BT-K (meals types 1-9) | 4.54 | 3.1 | 5.92 | 0.63 |
| HDI (0-9 points) | 3.32 | 1.75 | 5.0 | 0.87 |

The largest percentage of the patients (76%) were women with BMI above the standard (BMI ≥ 25 kg/m$^2$). The group of obese women (BMI ≥30 kg/m$^2$) comprised as much as 39% of studied population. Among the participants of the study there were none with BMI showing underweight (BMI < 18,5 kg/m$^2$).

Significant percentage of tested women (73%) had waist circumference ≥ 88 cm, which shows on high risk of metabolic syndrome occurrence among the respondents. In test group of overweight (BMI ≥ 25 kg/m²) and obese (BMI ≥ 30 kg/m²) women a large majority. i.e. 95.65%, represented android body type.

Analysis of the results of qualitative assessment with three diet quality indexes is shown in Table 2.

When analysing the results of *Szewczyński's* et al. diets' classification (SDC), in order to estimate the average results from menus assessments it was assumed that the classes I, II, III and IV correspond to points 1, 2, 3 and 4, respectively. The average score for the meals assessed with this test was $2.55 \pm 0.96$ points. Results obtained from the average value proved that the best - appropriate menus belonged to class I (≥ 1; < 1.5 points) and characterized only 15% of tested population. Menus of the majority of respondents belonged to classes II (≥ 1.5; < 2.5 points), III (≥ 2.5; < 3.5 points) or IV (≥ 3,5 points). Diets of 85% of women belonging to classes II, III and IV were classified as improper and this indicated dietetic mistakes. Menus from more than half of the respondents (52%) belonged to class III, so the meals of those women contained less than 2 portions of animal proteins and/or less that 1 portion of milk/dairy products, and/or less that 1 portion of vegetables and fruits, and/or the intervals between the meals exceeded 5 hours during the day. The distribution of women belonging to the remaining classes was similar and was within the range 15-18%.

Another qualitative index of dietary assessment of the respondents with PCOS was *Bielińska's* test with *Kulesza's* et al. modification. The average score (points) obtained in this test was $4.54 \pm 0.63$. The minimum score obtained for a 4-day dietary assessment in this test group was 3.1, whereas the maximum score was 5.92. The average score allowed to classify the meals into certain types from type 1 to 9. Diets described as rational constituted only 18%, and the meals belonging to this group were meals of type 5 (> 4; ≤ 5 points), 6 (> 5; ≤ 6 points) or 7 (> 6; ≤7 points). The majority of menus (82%) was assessed as irrational. This included the following types of meals: 1 (≤ 1 points), 2 (> 1; ≤ 2 points), 3 (> 2; ≤ 3 points), 4 (> 3; ≤ 4 points), 8 (> 7; ≤ 8 points) or 9 (> 8 points). Those were the meals differing from the standard requirements by the recommended macronutrients structure (protein, fats, carbohydrates), and were also characterized by very low amount of vegetables and fruits.

The average value of Healthy Diet Indicator among the women with PCOS amounted to $3.32 \pm 0.87$ out of 9 points which could be obtained. None of the respondents received more than 5 points. Menus assessed as improper were characterized by inappropriate consumption of fatty acids (saturated and polyunsaturated), carbohydrates (compound, mono- and oligosaccharides), protein, dietary fibre, fruits and vegetables, legumes, nuts, grains and cholesterol. 18% of diets received only 2 points, almost 40% of menus received 3 points, and 24% - 4 points, which was less than half of the points possible to be given in this test. It can be thus assumed that 100% of diets assessed with HDI test was improperly composed.

The analysis of the results from the assessment of 3-day food diaries combined with 24h food records from the respondents with PCOS is presented in Table 2. After qualitative dietary assessment the diets were divided into quartiles according to the number of obtained points (Figure 1).
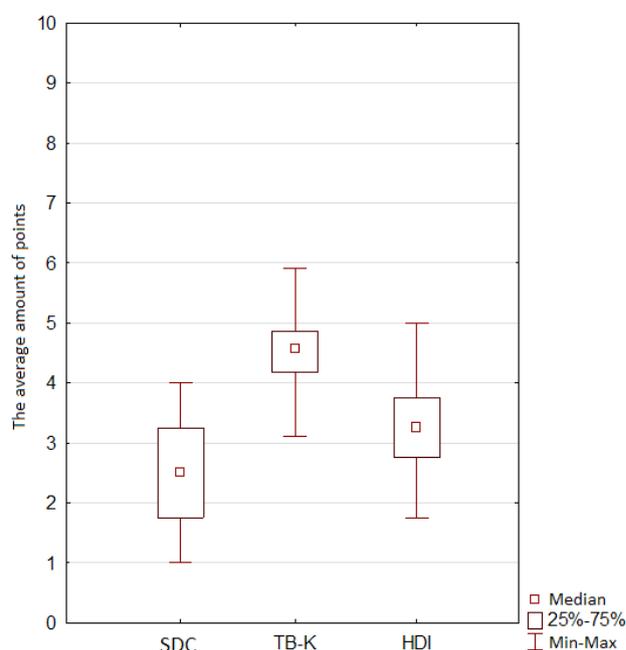


Figure 1. The graph of distance distribution (median, first and third quartile, minimal and maximal value) from dependent values (qualitative dietary indexes)

Due to the analysis of *Pearson's* correlation coefficient it was determined that in the group of women with PCOS there was a correlation between the scores obtained from the diets assessment using diet quality indexes (SDC, BT-K, HDI) and anthropometric parameters of these women (age, body weight, waist and hip circumference, BMI, WHR). Statistically significant correlation was observed only for HDI and BMI (-0.321) and body weight (-0.314). The more points were received during the point quality assessment of the diet with HDI the lower the BMI and the body weight. Other correlations were weak and statistically insignificant. The above results are shown in Table 3.

Table 3. Correlations between the variables determining the quality of the diets and independent variables (anthropometric parameters)

| Pearson' correlation coefficient | Age [years] | Body weight [kg] | Waist circumference [cm] | Hip circumference [cm] | BMI [kg/m²] | WHR [cm/cm] |
|---|---|---|---|---|---|---|
| SDC average score | 0.092 | 0.065 | 0.105 | -0.045 | 0.169 | 0.226 |
| BT-K average score | -0.081 | -0.149 | -0.072 | -0.155 | -0.255 | 0.054 |
| HDI average score | 0.017 | -0.314 | -0.194 | -0.209 | -0.321 | -0.142 |

The correlation was determined between the diet quality indexes classifying food rations into certain types or classes (SDC, BT-K) and anthropometric parameters (age, body weight, waist circumference, hip circumference, BMI [kg/m²], BMI category, WHR [cm/cm], WHR category). On the basis of the performed analysis in the group of women with PCOS it was shown that there were statistically significant negative correlations between the classification of a certain type of meals assessed with BT-K and BMI [kg/m²] (-0.314), and between the classification of a certain type of meals assessed with BT-K and BMI category (-0.390). Other results are weakly linked and statistically insignificant (Table 4).

Table 4. Analysis of correlations between qualitative dependent variables (diet quality indexes) and independent variables (anthropometric parameters)

| Spearman's correlation coefficient | Age [years] | Body weight [kg] | Waist circumference [cm] | Hip circumference [cm] | BMI [kg/m²] | WHR [cm/cm] | Age [years] | Body weight [kg] |
|---|---|---|---|---|---|---|---|---|
| Classification into meal class - SDC | -0.118 | -0.033 | 0.016 | -0.037 | -0.151 | -0.178 | -0.006 | -0.028 |
| Diet assessment according to point scale - BT-K | -0.213 | -0.198 | -0.246 | -0.260 | -0.314 | -0.390 | -0.179 | -0.075 |

## DISCUSSION

Random studies performed in Australia [24] or in Italy [1] confirmed that overweight or obesity and the excess of abdominal fatty tissue often occur in women with PCOS. BMI values in our study were similar to those observed by other researchers: 29.7±4.8 kg/m² [7] and 27.4±7.3 kg/m² [3]. There are also studies indicating significantly higher average BMI value for women with PCOS: 32.1±9.3 kg/m² [26]. This could be attributed to higher average age of tested patients (46.7±5.8) and criteria used to diagnose the disease. Average WHR value in our study was higher (0.92±0.08) in comparison to the results of *Wright* et al. (0.837±0.097), which favours the development of metabolic diseases.

In the study of *Hann* et al. [11], who analyzed the diets of women with average body weight of 70.1 ± 0.8 kg, and average BMI 26.1 ± 0.3 kg/m², 3-day food reports were assessed using HDI. The study showed that women who received high notes in HDI test often had lower BMI and less often consumed alcohol, as compared to the respondents who received lower HDI scores. The Healthy Diet Indicator, based on WHO's 2003 nutrient intake goals to prevent chronic diseases worldwide, represents a globally applicable diet quality index that has been shown to be associated with all-cause mortality. Studies of other authors show that a healthy diet, based on the WHO guidelines, is significantly associated with decreased cardiovascular disease (CVD) mortality in US and southern European elderly [14]. The same research group also reported on the correlation between the HDI test score and the length of life [13]. It is thus obvious that among the women with PCOS there exist another environmental factor - the diet, influencing the development of CVD and the longevity. Studies using testing HDI and therefore the quality of the diet with the occurrence of cancer also searched *Hawrysz* et al. [12] . He showed that the higher level of nutritional knowledge was associated with a higher pro-healthy diet quality and lower risk of breast cancer in women or lung cancer in men. In contrast, a lower level of nutritional knowledge was associated with a lower quality diet and a higher risk of both types of cancers [12].

In our study also the national tests for dietary quality assessment were used: BT-K and SDC, recommended by the National Institute of Food and Nutrition. The studies using BT-K conducted *Hamulka* et al. analyzing the nutrition of school children showed significant irregularities relating to the composition breakfast [10]. The menus assessment of preschool daily food rations were also Evaluated applying SDC scoring method and TB-K, showing serious bugs relating to the nutritional value and the share of each product group [2]. Unfortunately, our

analyses showed that only BT-K could be a reliable method of assessment of the correlation between the nutritional status and the diet, because this test showed statistically significant correlations between BMI and BMI category.

## CONCLUSIONS

In this study the quality assessment of the diets was performed and compared to the nutritional status of women with polycystic ovary syndrome. We determined the relation between the diet, nutritional status and PCOS diagnosed according to Rotterdam's criteria.

1. WHR values in the majority (93%) of the tested women with PCOS and higher BMI showed on the risk of the occurrence of metabolic syndrome.

2. Qualitative tests, especially HDI and BT-K, can be successfully used in qualitative assessment of the diets of women with PCOS.

3. In almost all tested women with PCOS we observed significant irregularities with respect to diets quality, which allows us to state that inappropriate diet is one of the main reasons of PCOS diagnosed with Rotterdam's criteria.

4. Correct diet and maintenance of proper nutritional status should be the basis of the therapy for women with PCOS diagnosed with Rotterdam's criteria.

**Conflict of Interest**
*All authors declare no conflict of interest. Informed consent was obtained from all individual participants included in the study.*

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