

SELF-REPORTED EATING BEHAVIOR AND NUTRITION KNOWLEDGE IN WOMEN STARTING DIETARY TREATMENT COMPARED TO WOMEN WHO ACHIEVE TREATMENT GOALS FOR SIMPLE OBESITY

ZACHOWANIA ŻYWIENIOWE I WIEDZA NA TEMAT ŻYWNOCI I ŻYWIENIA W OCENIE KOBIET ROZPOCZYNAJĄCYCH DIETETYCZNE LECZENIE W PORÓWNANIU DO KOBIET OSIĄGAJĄCYCH CEL LECZENIA OTYŁOŚCI PROSTEJ

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- C. Data analysis/statistics
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Summary

Background. The goal of the study was to compare self-reported eating behavior and knowledge of nutrition in cohorts of women with simple obesity, who begin nutritional intervention to treat obesity, and in women who achieved the goal of obesity treatment, i.e. reduction of initial body mass by a minimum of 10%.

Material and methods. The study was conducted in a group of 38 women with simple obesity who were starting dietary treatment (aged 18-72, mean 41, SD 14.95) and 49 women with simple obesity, who, as a result of dietary treatment for obesity, achieved a body mass reduction by at least 10% (aged 18-67, mean 41, SD 13.44). The survey also included a control group of 100 women with normal body mass (aged 19-59, mean 33, SD 13.29). The study used the Questionnaire of Eating Behavior.

Results. Women with simple obesity starting dietary treatment were characterized by a paradoxically higher intensity of characteristics of a pro-health diet as well as a higher intensity of unhealthy diet characteristics, compared to women with normal body mass. Women starting treatment compared to women who achieved successfully completed treatment, exhibited a significantly lower intensity of pro-health diet characteristics and higher intensity of unhealthy diet characteristics. The level of nutrition knowledge among healthy women was significantly higher compared to obese women starting treatment. The women who achieved the goal of treatment were characterized by a higher level of nutrition knowledge compared to those starting treatment.

Conclusions. There are significant differences between the studied cohorts of women in terms of level of nutrition knowledge and eating behaviors associated with dietary treatment for obesity.

Keywords: woman's health, eating behavior, nutrition, obesity, Questionnaire of Eating Behavior

Streszczenie

Wprowadzenie. Celem pracy było porównanie zachowań żywieniowych oraz wiedzy na temat żywności i żywienia w grupach kobiet z otyłością prostą, rozpoczynających dietetyczne leczenie otyłości oraz kobiet, które osiągnęły cel leczenia otyłości w postaci 10% redukcji wyjściowej masy ciała.

Materiał i metody. Badanie zrealizowano w grupie 38 kobiet z otyłością prostą rozpoczynających dietetyczne leczenie otyłości (wiek 18-72 lata, średnio 41, SD 14.95) oraz 49 kobiet z otyłością prostą, które osiągnęły cel leczenia w postaci obniżenia masy ciała o minimum 10% (wiek 18-67 lat, średnio 41, SD 13.44). Dodatkowo w badaniu uwzględniono grupę kontrolną 100 kobiet o prawidłowej masie ciała (wiek 19-59, średnio 33, SD 13.29). W badaniu zastosowano Questionnaire of Eating Behavior.

Wyniki. Kobiety z otyłością prostą rozpoczynające dietetyczne leczenie otyłości wykazywały paradoksalnie większe nasilenie prozdrowotnych cech diety, a także większe nasilenie antyzdrowotnych cech diety w porównaniu do kobiet z prawidłową masą ciała. Kobiety rozpoczynające leczenie w porównaniu do tych, które osiągnęły cel leczenia, wykazywały znamienne niższe nasilenie prozdrowotnych cech diety i większe – antyzdrowotnych cech diety. Poziom wiedzy żywieniowej kobiet zdrowych był znacząco większy niż kobiet z otyłością rozpoczynających leczenie. Kobiety, które osiągnęły cel leczenia cechowały się większą wiedzą żywieniową w porównaniu do rozpoczynających leczenie.

Wnioski. Wykazano istotne różnice pomiędzy badanymi kohortami kobiet w zakresie poziomu wiedzy żywieniowej oraz zachowań żywieniowych, powiązane z dietetycznym leczeniem otyłości.

Słowa kluczowe: zdrowie kobiet, nawyki żywieniowe, żywienie, otyłość, kwestionariusz QEB

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Introduction

Obesity is a chronic disease that, according to the World Health Organization's (WHO) definition, manifests itself by an abnormal or excessive accumulation of fatty tissue which causes a health hazard, especially regarding non-communicable chronic diseases (NCD) [1,2]. WHO statistics point out that the prevalence of obesity across the world has tripled since 1975. Consequently, in 2016 the problem of abnormally high body weight concerned 1.9 billion adults, including 650 million suffering from obesity [1]. Between 1980 and 2015, obesity prevalence doubled in 73 countries, an upward trend also observable in most other countries [3]. The results of the European Health Interview Survey (EHIS) of 2014 shows that being overweight affects 30.1% of women in Poland and obesity 16%, the prevalence of obesity in women increasing with age to achieve the maximum in the age range of 70-79 years, when it affects 27.8 % of women [4]. According to the Multi-Centre National Population Health Examination Survey results (WOBASZ II study) of 2013-2014, in Poland, being overweight affects 30.5%, and obesity, 25% of women [5]. The growing incidence of obesity observed in Poland after 1990 contributed considerably to the deterioration in the health status of the Polish population between 1991 and 2005 [5].

Despite increasing knowledge on the genetics of obesity, the WHO stands by its position on the etiopathogenesis of the disease: "The fundamental cause of obesity and overweight is an energy imbalance between calories consumed and calories expended", resulting from increasing consumption of energy-dense foods and increasing physical inactivity [1], with behavioral causes of obesity being related to environmental and societal changes [1,6]. Therefore, a significant element of the etiopathogenesis of this disease is individual behaviors, which are connected both to the context of people's lives and levels of health awareness. Consequently, it is reasonable to conduct research not only on the "hard" biogenetic aspects of the disease, but also on its behavioral aspects, also taking account of relevant changes occurring during the course of treatment.

This pertains to simple (idiopathic, alimentary) obesity, which constitutes over 90% of all obesity cases in adults. Simple obesity is characterized by a chronic positive energy balance, which is caused by excessive food intake in proportion to energy expenditure. Diagnosis requires the exclusion of secondary causes of obesity in patients where medical history or physical examination indicates the occurrence of additional pathology [7]. In the cases of secondary obesity that are estimated to account for several per cent of all obesity cases, the fundamental cause of an increase in body weight and fatty tissue is clinical pathology [7]. Regardless of the initial cause, however, the underlying cause of body fat accumulation is always a positive energy balance [8].

In accordance with the "complications-centric approach" paradigm furthered by the American Association of Clinical Endocrinologists (AACE) and the American College of Endocrinology (ACE), the principal goal of medical treatment of obesity is to reduce the risk of, or to eliminate the complications of obesity, thereby improving the health status and quality of life of patients without emphasis on body weight reduction *per se* [2]. The degree of body weight reduction recommended in the ACE/AACE guidelines is subordinated to attaining the overriding goal of reducing the risk/intensity of obesity complications. With reference to the majority of obesity-associated complications, a 10% reduction in initial body weight is regarded as the sufficient goal of dietary management that should improve a patient's health status [2].

The aim of the study was to compare self-reported eating behavior and nutrition knowledge in two separate cohorts of women with simple obesity: those starting nutritional interventions for obesity treatment, and those who achieved the goal of obesity treatment, i.e. a reduction in initial body weight by a minimum of 10%.

Material and methods

The survey was conducted in a group of 87 women with simple obesity – 38 starting dietary treatment for obesity (aged 18-72 years, mean 41, SD 14.95) and 49 who achieved the goal of dietary treatment, i.e. a reduction of initial body weight by a minimum of 10% (aged 18-67 years, mean 41, SD 13.44). The respondents were selected by a purposive, non-random sampling method. The control group consisted of 100 healthy women with normal body weight (Body Mass Index, BMI 18.15-24.97 kg/m², mean 22.14, SD 1.87), aged 19-59 (mean 33 years, SD 13.29).

Table 1. Characteristics of the study group

Characteristics	Respondents with simple obesity starting treatment (n=38)	Respondents who achieved the aim of treatment (n=49)	Respondents with normal body weight (n=100)
Age (mean; SD)	41; 14.95	41; 13.44	33; 13.29
BMI (kg/m ²) (mean)	36.6	26.99	22.14
Waist-to-Hip Ratio (WHR) (mean)	0.96	0.83	----
Fat Mass (FM) (mean)	44.56%	32.61%	----

Being aware of the impact of age on eating behavior, the authors assumed that the difference in mean age between the study and the control group (8 years, 41 vs. 33) does not cause significant differences in eating behavior patterns since the mean ages fall within the same age group with respect to Polish dietary recommendations [9].

The participants were recruited from community dietetic outpatient clinics in Lublin, Warsaw, Kraśnik, and Puławy (Poland); the clinics involved were run by dietitians with specialist vocational education. The respondents were selected by purposive, non-random sampling method. The participants received lifestyle intervention in accordance with the European [10] and Polish guidelines for obesity treatment [11]. Dietary management involved diets with reduced calorie content, compared to individually established demand, with the use of a calorie deficit between 500-800 kcal. Diets were applied with various proportions of macronutrients, adjusted to patients' needs and preferences, and covering requirements for vitamins and minerals according to nutritional standards. All patients were encouraged to perform regular physical exercises [2,7,10-13]. Data concerning the duration of nutritional intervention and the number of visits were not collected. Using the devices available in the clinics involved, bioelectrical impedance analysis (BIA) was performed to assess body composition in the study group. Standardized conditions for BIA measurement were fulfilled. The measurement was performed maintaining standardized conditions in the supine position, while lying on a non-conductive surface, with the following body position: lower extremities relative to each other at an angle of 45°, and upper extremities relative to the trunk at an angle of 30°, fasting, after 10-minute rest.

The criterion for inclusion in the study group of women starting dietary treatment for obesity was the diagnosis of simple obesity, taking into account the exclusion of secondary obesity based on analysis of medical documentation and medical histories of the patients. Therefore, the exclusion criterion was the diagnosis or treatment of diseases underlying secondary obesity.

The inclusion of women in the study was motivated by the intention to discern the behavioral specificity of obesity concerning nutritional behavior in this sex group, taking into account relevant differences between women starting treatment versus achieving the goal of treatment. The rationale for gearing the study towards women was also motivated by the fact that gender is an important factor in determining health behaviors including nutritional habits. Further planned research on the behavioral aspects of obesity in men will enable demonstration of such sex-dependent differences.

In the entire study group (i.e. both women starting dietary treatment and those who achieved the aim of treatment), the percentages of women with higher, secondary, primary/basic vocational, and junior high-school education were 43%, 51%, 5% and 1%, respectively. Taking into account the self-reported data, 17% of respondents assessed their financial situation as 'above average', 78% as 'average', and 5% as 'below average'. According to the size of the place of residence, the distribution of the study group was as follows: 22% of respondents lived in rural areas, 8% in towns with less than 20,000 inhabitants, 26% in towns with 20,000 – 100,000 inhabitants, while 44% lived in towns with more than 100,000 inhabitants.

The respondents were informed about the goal of the survey and gave their consent to participate. The study design was approved by the Bioethical Commission of the Medical University of Lublin (No. KE-0254/290/2017).

The following research tools/methods were used:

1. The author's questionnaire to evaluate the socio-demographic characteristics of respondents
2. The Questionnaire of Eating Behavior (QEB) developed by the Behavioral Conditions of Nutrition Team, Committee of Human Nutrition Science, Polish Academy of Science, headed by J. Gawęcki, MD, PhD [14], designed to investigate eating behavior and nutritional knowledge. It is a food-frequency questionnaire (FFQ) containing a short list of foods (fewer than 50 items) – without questions regarding portion size – a type of short and qualitative FFQ [15,16]. The daily frequency (times/day) was assessed, with the following possible answers: never (0), 1-3 times a month (0.06), once a week (0.14), several times a week (0.5), once a day (1), several times a day (2) [14,17]. According to the procedure of QEB data processing

[14,17], two indices of diet quality were calculated: pro-Healthy-Diet-Index-8 (pHDI-8) and non-Healthy-Diet-Index-8 (nHDI-8). The former comprises data on the intake of eight groups of food with a potentially beneficial impact on health, including wholemeal bread, coarse-grained cereal products, milk and dairy products, poultry, fish, pulses, vegetables and fruit, while the latter presents data on the intake of nine food groups with an adverse impact on health, including white bread, white purified cereal products, fast food, fried food products, fatty meat and fatty meat products, tinned meat, sweets, as well as sweetened, energizing and alcoholic beverages. The indices of daily intake frequency (factor/day) were added together; subsequently, the obtained values of the total frequency of consumption of the two food groups were categorized into three brackets of index magnitude:

- 0-5.33: low intensity of pro-health or unhealthy nutrition characteristics
- 5.34-10.66: moderate intensity of pro-health or unhealthy nutrition characteristics
- 10.67-16: high intensity of pro-health or unhealthy nutrition characteristics

Nutrition knowledge was evaluated using 26 statements. Respondents were to choose one of the following responses: “I agree”, “I don’t agree”, or “I have no opinion.” According to the procedure of QEB data processing [14,17], analysis of the opinions on food and nutrition enabled to distinguish the groups of respondents characterized by different levels of nutrition knowledge. One point was awarded for each correct answer, the points being subsequently added together, and the respondents assigned to one of three groups characterized by insufficient (0-10 scores), sufficient (11-15 scores) or good (16-26 scores) nutrition knowledge [17].

3. In the study group, histories of previous medical treatment were also obtained in the analysis of medical documentation in order to exclude secondary obesity.
4. Anthropometric measurements in the study group were performed in accordance with the WHO guidelines [18], with consideration of the measurement of weight up to the nearest 0.1 kg, and height to the nearest 0.5 cm. BMI (in kg/m²) was calculated as body weight divided by the square of height expressed in meters. In the control group, BMI was calculated based on self-reported data on weight and height. Waist and hip circumference were measured according to WHO guidelines [18]. Based on these measurements, Waist-to-Hip Ratio (WHR) was calculated in the study group.

The study participants were recruited and asked to complete the questionnaire during their preliminary visit to a particular community dietetics clinic when starting the obesity treatment (n=38) or during a subsequent visit when a 10% reduction in initial body weight was observed (n=49). Recruitment to each group took place independently based on targeted selection.

Statistical analysis

The Statistica 12 package was used for performing statistical analysis. The relationships between qualitative variables in the studied cross-sections were analyzed using the Pearson’s chi-square test for independence, and in the case of failure to satisfy the assumption of minimum expected quantities, the chi-square test with Yates’ continuity correction was applied. For quantitative variables, the normality of distributions was first verified using the Shapiro-Wilk normality test. For cases when one of the compared distributions in the groups/measurements deviated from the normal, the non-parametric Mann-Whitney U test was applied to compare the significance of differences of the studied parameters between the two groups. If the normality of distributions was retained, the two groups were compared using the Student t-test for independent samples (in cases of failure to satisfy the assumption of variance equality, the t-test with a separate estimation of variance was performed). The significance level was set at $p=0.05$.

Results

At the first stage of analysis, eating behavior patterns of the respondents starting dietary treatment for obesity and controls were compared, taking into account the intensity of characteristics of a pro-health diet (pHDI-8) and an unhealthy diet (nHDI-8). Paradoxically, obese individuals were characterized by a higher intensity of characteristics of a pro-health diet than those with normal body weight ($Z=-3771$; $p<0.001$). Furthermore, according to the categorized levels of intensity of characteristics of a pro-health versus an unhealthy diet, 78% of respondents with normal body weight and only 52.6% of obese individuals starting treatment were characterized by a low intensity of characteristics of a pro-health diet ($\chi^2=8.6$; $p=0.03$). The above percentages demonstrate that intentional pro-health nutrition behaviors are better implemented by obese women (presumably motivated by the intention of reducing body weight). However, obese women starting treatment were also characterized

by a greater intensity of unhealthy diet characteristics, as compared to controls ($Z=-5561$; $p<0.001$). Moreover, the distribution of categorized levels of intensification of unhealthy diet characteristics significantly differed between the two groups, indicating an analogous regularity ($\chi^2=22.6$; $p<0.001$) (Table 2).

Table 2. Pro-health and unhealthy diet characteristics according to stage of dietary treatment and in controls

Intensity of pro-health and unhealthy diet characteristics	Respondents starting dietary treatment for obesity		Respondents who achieved the aim of dietary treatment		Controls	
pHDI-8						
M / Me	5.44 / 4.99		6.65 / 6.76		4.01 / 3.76	
Low	52.6%	n=20	28.6%	n=14	78.0%	n=78
Moderate	47.4%	n=18	67.4%	n=33	22.0%	n=22
High	0.0%	n=0	4.1%	n=2	0.0%	n=0
nHDI-8						
M / Me	3.73 / 3.67		1.18 / 0.62		1.53 / 1.38	
Low	21.0%	n=8	100%	n=49	0.0%	n=0
Moderate	79.0%	n=30	0.0%	n=0	99.0%	n=99
High	0.0%	n=0	0.0%	n=0	1.0%	n=1

Notes: Intergroup comparisons and p values are given in the text. Abbreviations: M - average, Me - median, pHDI-8 - pro-Healthy-Diet-Index-8, nHDI-8 - non-Healthy-Diet-Index-8.

During the next stage of analysis, eating behavior was compared in the subgroups of the study group, i.e. among females starting treatment and those who achieved the aim of treatment. Women with obesity who were starting treatment were characterized by a significantly lower intensity of characteristics of a pro-health diet, as compared to women with obesity who had already attained the aim of the treatment ($t=-2.670$; $p=0.009$). More than half (52.6%) of women with obesity who started treatment were found to be characterized by a low level of pro-health diet characteristics, compared to barely one-third (28.6%) in the group who achieved the aim of the treatment.

In turn, moderate and high intensity of pro-health diet characteristics were more frequently found among female respondents that had received treatment for obesity ($\chi^2=6.2$; $p=0.046$). Moreover, the results concerning intensity of unhealthy diet characteristics showed positive pro-health changes associated with dietary management of obesity. Respondents with obesity starting treatment were characterized by higher intensity of unhealthy diet characteristics than those with obesity who had already achieved the aim of the treatment ($Z=-5.565$; $p<0.001$). The above is also confirmed by the fact that all the women (100%) who achieved the aim of treatment were characterized by a low level of unhealthy diet characteristics ($\chi^2=22.6$; $p<0.001$). The results obtained suggest that dietary management of simple obesity may have had a beneficial effect on respondents' eating behaviors (Table 2).

At the subsequent stage of analysis, levels of nutrition knowledge were compared in the group starting dietary treatment for obesity and in controls (Table 3) and statistically significant differences were demonstrated: the former group was characterized by a significantly lower level of nutrition knowledge than the latter (controls) ($Z=-4.756$; $p<0.001$). It should also be emphasized that more than one-fourth (26.3%) of obese respondents exhibited an insufficient level of nutrition knowledge, as compared to only 8% in the control group. Moreover, the prevalence of a good level of nutrition knowledge varied in the groups compared. Good levels of nutrition knowledge were found in 32% of controls and in none of the obese respondents starting treatment ($\chi^2=20.1$; $p<0.001$). Furthermore, levels of nutrition knowledge were compared in the group starting dietary treatment for obesity and in those who achieved the aim of the treatment recommended by ACE/AACE. The first group was shown to be characterized by a significantly lower level of nutrition knowledge than the post-treatment group ($Z=-2.295$; $p=0.003$). There were significant intergroup differences in percentages of respondents characterized by higher levels of nutrition knowledge. A sufficient level of nutrition knowledge was found in 73.7% of those starting treatment and, in 51% of respondents after treatment, while a good level of nutrition knowledge was reported in 26.5% of post-treatment respondents and, in none of the respondents starting treatment ($\chi^2=12.0$; $p=0.002$). The presented results indicate that dietary treatment for obesity differentiates the subjects in terms of level of nutrition knowledge (Table 3).

Table 3. Levels of nutrition knowledge in the group starting obesity treatment, post-treatment group and controls

Level of nutrition knowledge	Respondents starting dietary treatment for obesity		Respondents who achieved the aim of dietary treatment		Controls	
M / Me	10.34 / 10.50		13.37 / 14.00		14.04 / 13.50	
Insufficient	26.3%	n=10	22.5%	n=11	8.0%	n=8
Sufficient	73.7%	n=28	51.0%	n=25	60.0%	n=60
Good	0.0%	n=0	26.5%	n=13	32.0%	n=32

Notes: Intergroup comparisons and *p* values were included in the text. Abbreviations: M – average, Me – median.

Discussion

The present study is a part of research concerning the efficacy of obesity treatment, in which not only weight loss, but also behavioral changes are considered intervention endpoints [19]. The behavioral dimension of obesity treatment is vital as the inclusion of new eating behaviors in the daily routine is a prerequisite for the efficacy of obesity treatment and maintenance of its effects [19-21]. The major goal of the study was to determine whether dietary management of simple obesity resulted in lasting behavioral changes in eating patterns (behaviors) and affected level of nutrition knowledge. Women with obesity were found to exhibit a paradoxically higher intensity of pro-health diet characteristics compared to controls, which is likely a result of changes to eating behaviors already initiated prior to starting treatment. Lange et al. have demonstrated that modification of dietary pattern is a behavior strategy typically applied by women to reduce body weight, yet not men who tend to increase physical activity instead [22,23]. Several other studies have also highlighted gender-dependent differences in dietary patterns. The studies conducted under the Behavioral Risk Factor Surveillance System (BRFSS) have revealed that in the USA, the strategies applied by overweight or obese persons significantly changed between 1996 and 2003. Generally, the vast majority of the obese (86% of males and 92% of females) used energy restrictions or ate less fat, or applied both strategies simultaneously, however, during that period (i.e. 1996-2003), the number of individuals using exclusively energy restrictions (in accordance with the obesity treatment guidelines) doubled. In the groups of females and individuals with higher education, these differences were more pronounced [24]. The BRFSS studies also demonstrated that overweight or obese women are 1.5 times more likely to attempt to reduce their body weight than males, and do so at lower BMI values [24], which results from the greater social pressure women are subjected to regarding the shape of their bodies. This may also account for the fact that males seek weight loss programs less often [25,26]. According to Robertson et al., men are under-represented in randomized trials of weight loss interventions, which may be associated with the fact that dieting is perceived as a feminine activity [26].

In our future research, we plan to investigate behavioral changes in obese men in relation to the dietary management of obesity. Moreover, the intensity of unhealthy diet characteristics was found to be higher in the group of obese females, which is in agreement with a number of studies that indicate errors in the nutritional habits of obese individuals [22,23,27-29]. The lack of studies conducted using the same tool (QEB) makes it impossible to compare the results obtained. Therefore, select studies on the eating behaviors of obese individuals will be discussed. In their study, Bailey et al. demonstrated that the strongest predictor of obesity in both genders is the amount of fat intake [30]. A Polish study by Cymerys et al. also indicated nutritional errors as correlates of waist circumference in obese individuals of both genders, particularly excessive consumption of fat, fast foods, or sweetened beverages [31]. A study involving 11,748 adult Canadians, conducted as part of the Canadian Community Health Survey 2.2, showed a crucial relationship between dietary patterns and obesity risk. The subjects ranked in quartile four of the optimum nutrition recommendations and showed a 53% lower odds risk of unhealthy obesity. This relationship has also been demonstrated in cases of obesity without accompanying chronic diseases [32]. Moreover, a higher quality of diets has been found to be associated with a lower odds ratio of obesity in the Australian population (both genders) [33]. In contrast, the Coronary Artery Risk Development in Young Adults Study (CARDIA) covering the period of 1985-2005 (20 years of observation) has not confirmed a longitudinal association between diets consistent with recommendations for healthy nutrition, outlined in the 2005 Dietary Guidelines for Americans, and long-term weight maintenance in young American adults [34]. Nevertheless, the majority of findings reported in the literature between 1990 and 2016 have confirmed significant positive associations of diet characteristics with obesity [35].

Our results are consistent with the reports cited above, showing significant differences in dietary characteristics in the pre- and post-treatment female cohorts and healthy female controls. Our findings, however, have an innovative element as they prove, or additionally demonstrate, that women starting obesity

management attempt to implement health-oriented nutrition habits preceding the initiation of treatment.

Furthermore, there were statistically significant differences in eating behaviors between the pre- and post-treatment subgroups. The intensity of pro-health diet characteristics was higher while the intensity of unhealthy diet characteristics was lower in women after lifestyle interventions, which may be the result of the education provided by dietitians. The literature suggests that a dietitian should be a guide in helping patients change their eating behaviors [36]. It is noteworthy that despite the dynamic development of advanced technological applications to help foster behavioral changes in obesity treatment [21,37], lifestyle dietary intervention implemented in the context of an interpersonal patient-dietician relationship remains a fundamentally effective strategy for achieving the targets and goals of obesity treatment [2,13,20,38].

Another aim of our study was to compare levels of nutrition knowledge in the studied groups. A significantly higher level of nutrition knowledge was found in the control group, compared to obese women starting treatment. According to a Polish study by Kostrzewa-Zabłocka et al., patients characterized by a higher level of nutrition knowledge exhibited lower values of BMI and WHR indices, compared to those with a lower level of knowledge [39]. However, several studies have demonstrated that there is no relationship between levels of nutrition knowledge and eating behavior patterns, both in adults [28,29] and in young people [40]; their authors have emphasized that a number of social, economic, cultural, and other factors limit the possibilities of implementing the recommended behaviors [6].

Regardless of the optimistic results of the WOBASZ II study that demonstrated improved levels of health knowledge in the Polish population (compared to the previous WOBASZ study [41]) it should be noted that level of knowledge is not the only predictor of behaviors, because the implementation of recommended behaviors is also determined by environmental conditions, which are often patient-independent [6]. Moreover, it should be emphasized that knowledge of the principles of optimum nutrition and physical activity are insufficient for attaining and sustaining lifestyle changes that determine reduction of excess body weight [20]. However, application of this knowledge in practice may significantly enhance health-oriented policy measures that reduce obesogenic environmental influences [20], described by the Swinburn's concept of obesogenic environment [42].

In our study, higher levels of nutrition knowledge in women who achieved the aims of obesity treatment, compared to those starting treatment, reveal the potential, beneficial effects of dietary counselling for obese patients. However, the methods used in our study do not allow us to draw conclusions about the cause-effect relationships in this area.

It should be stressed that changes in nutrition habits of obese patients can be achieved most effectively by a simultaneous increase in level of nutritional knowledge and acquisition of abilities such as *inter alia* self-observation and estimation of energy intake levels, control of unconscious caloric intake, and a competent selection of foodstuffs or preparation of meals [43].

When commenting on this part of the analysis, the results of the WOBASZ programme should be noted, which demonstrated that a low level of knowledge on the prevention of cardiovascular diseases was reflected in the suboptimal nutrition habits of patients with a history of coronary incidents [44].

Limitations of the study

The selection of patients was purposive: therefore, the conclusions cannot be generalized because they only concern the studied groups. Moreover, the results may have been influenced by the specificity of the studied group of obese women who were participating in the community, commercial, paid dietary treatment for obesity, and thus likely had a high level of motivation to achieve the set aims.

Moreover, the results concerning eating behaviors and level of nutrition knowledge in the groups of women starting treatment as well as those achieving the aim of the treatment are not the outcome of prospective observation of the same group of females.

In light of current knowledge, further studies are required to examine predictors of behavioral changes achieved in the treatment of obesity, taking the stage of treatment into consideration, as well as the specific needs and profiles of patients, including patients' experiences related to past attempts at obesity treatment, their psychological profile etc. [20,21].

Our study only took into account women, who are more receptive to health promotion messages concerning lifestyle changes. The issues of behavioral changes in men require further research. The absence of diseases underlying obesity was determined with the use of self-reported data and analysis of medical records. This approach does not fully guarantee the selection of women with simple obesity, as the patients' medical histories may be incomplete.

Conclusions

Our study, in which the standardized FFQ tool was used, identified the patterns of behavioral changes associated with dietetic interventions established in community outpatient departments in (sub)groups of obese women starting treatment and those who achieved their goal of obesity management according to AACE/ACE. The dietetic intervention is associated with improved quality of diets resulting from increased intensity of pro-health nutritional behaviors and decreased intensity of unhealthy behaviors. It is noteworthy that the above changes already take place during the stage preceding the initiation of professional dietetic management (increased intensity of pro-health behaviors was demonstrated in women starting treatment, as compared to controls). A higher level of nutrition-related knowledge seems to be the factor that favorably modulates nutritional behaviors as higher levels of nutritional knowledge were demonstrated in healthy women; moreover, contrary to inconsistent literature findings concerning the correlation between these variables, beneficial changes in nutritional knowledge were found to be associated with dietetic interventions.

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