ONLINE FIRST

This is a provisional PDF only. Copyedited and fully formatted version will be made available soon.

POLISH GYNECOLOGY
GINEKOLOGIA POLSKA
ORGAN POLSKIEGO TOWARZYSTWA GINEKOLOGICZNEGO
THE OFFICIAL JOURNAL OF THE POLISH GYNECOLOGICAL SOCIETY

ISSN: 0017-0011

e-ISSN: 2543-6767

Dietary patterns of Polish pregnant women in reference to prepregnancy BMI and gestational weight gain

Authors: Malgorzata Wiech, Ewa Kawiak-Jawor, Marta Baranska, Julia Zareba-Szczudlik, Halina Weker

DOI: 10.5603/gpl.98382

Article type: Research paper

Submitted: 2023-12-05

Accepted: 2024-05-12

Published online: 2024-09-05

ORIGINAL PAPERS / OBSTETRICS

Dietary patterns of Polish pregnant women in reference to prepregnancy BMI and gestational weight gain

Malgorzata Wiech[1], Ewa Kawiak-Jawor[2], Marta Baranska[1], Julia Zareba-Szczudlik[1], Halina Weker[1]

[1]*Institute of Mother and Child,Warsaw, Poland*
[2]*Łukasiewicz Research Network, Institute of Organization and Management in Industry, Warsaw, Poland*

ABSTRACT

Objectives: During the life cycle of a woman, pregnancy is the period when she is most open to changing her behaviour and lifestyle for the benefit of the child's development. Lifestyle changes include also the diet correction. The objective of the study was to assess, through identified dietary patterns, the diets of women in the second and third trimester of pregnancy in relation to their nutritional status before and during pregnancy.

Material and methods: The study was conducted among pregnant women, participants of childbirth education classes at the Institute of Mother and Child, based on food frequency questionnaire. The study involved 392 women in the age 19–40 years (first single pregnancy without complications). Dietary patterns were identified using the k-means method, based on groups of products.

Results: Three dietary patters were identified in the study group of women: dietary pattern 1 – cereal-milk diet, dietary pattern 2 – vegetable-fruit diet and dietary pattern 3 – cottage cheese-vegetable diet. Dietary pattern 3 occurred in 43.9% of underweight women, in 45.5% of women with normal weight and in 43.1% of women with excess body weight. Dietary pattern 1 occurred in about one third of women and dietary pattern 2 in about 20% in each group. A greater diversity in the frequency of identified dietary patterns was observed in relation to weight gain during pregnancy. The identified dietary patterns differed significantly in terms of the profile of macronutrients, most minerals and vitamins – E, C and B group vitamins.

Conclusions: The identified dietary patterns and their energy and nutritional profile indicate the need for monitoring the diets and nutritional education of pregnant women.
Keywords: nutrition; pregnancy; dietary patterns

Corresponding author:

Malgorzata Wiech

Institute of Mother and Child, Warsaw, Poland

e-mail: malgorzata.wiech@imid.med.pl

INTRODUCTION

The issues related to the diets of pregnant women remain relevant and extremely important for the health status of future generations. The appropriate diet of a woman during pregnancy has an impact on her nutritional status, course of pregnancy and the health of the child – in utero, childhood, and in adulthood. According to the theory of metabolic programming, unfavourable environmental conditions, including nutritional conditions, related to the deficiency or excess of nutrients during the fetal life may cause changes in the structure, metabolism and functioning of the body, thus increasing the risk of developing diet-related diseases in adulthood [1–3]. The nutritional status of a pregnant woman is one of the main factors ensuring the maintenance of pregnancy, its appropriate course and minimizing the risk of complications in the fetus. Maternal undernutrition may contribute to the reduction of the weight of the placenta, thus causing its dysfunction, intrauterine growth restriction, low birth weight of infant and premature delivery, whereas overweight and obesity in the mother may be conducive to hypertension, gestational diabetes, urinary tract infections, fetal macrosomia and surgical delivery. Therefore, it is important to monitor the weight gain during pregnancy with reference to the body mass index before pregnancy [4–7].

During pregnancy, the need for energy, essential nutrients, vitamins and minerals changes. Therefore, the balance between increased nutritional needs and the nutritional value of the diet should be achieved by the appropriate selection of products, the introduction of fortified foods and/or appropriate dietary supplementation [8].

In recent years, in nutritional assessment, an increasing attention has been paid to dietary patterns of various population groups as a comprehensive method for determining the relationship between the diet and the nutritional status. The analysis of dietary patterns is considered a holistic, alternative and complementary approach to assessing the dependencies between the diet and the risk of chronic disease by evaluating the impact of the overall diet and its complexity. Dietary patterns are defined as a set of numerous specific, co-existing characteristics describing the human diet. These characteristics may define the type and amount of nutrients, foodstuffs or groups of products, the frequency of eating meals, food preferences or avoidance of certain foods [9, 10]. Optimal eating patterns, which represent the set of nutritional characteristics that are the most beneficial for health, are referred to as "dietary patterns" [11].

Objectives

The aim of the study was to assess, through identified dietary patterns, the diets of women in the second and third trimester of pregnancy in relation to their nutritional status before and during pregnancy.

MATERIAL AND METHODS

Study group

The study was conducted in the years 2012–2018 among participants of childbirth classes conducted at the Institute of Mother and Child in Warsaw. The courses took place four times a year during this period, in which 796 pregnant women attended the childbirth classes. All women were invited to participate in the study. Out of 796 pregnant women, 448 (56%) decided to participate in the study and completed the questionnaire. The main reason for not completing the questionnaire was the lack of interest to participating in the study and the failure to meet the criteria (44%) of inclusion and exclusion from the study group. The study involved women who agreed to complete an anonymous questionnaire. A total of 448 questionnaires were collected, of which 392 were included in the study, only those that were completed without missing data (tab. 1). The inclusion criteria were: first and single pregnancy without complications, maternal age 19–40 years, and attending a childbirth education classes at the Institute of Mother and Child in Warsaw.

Analysis of the nutritional status

The nutritional status of pregnant women was examined based on body weight [kg], height [m] and body mass index BMI [kg/m^2] before and during pregnancy. Data were obtained from the questionnaire entries and current measurements. The recommendations of the American Institute of Medicine, which constitute the current medical standard, were used to assess the nutritional status of women before and during pregnancy [12].

Diet analysis

The diet was analysed using the data from the food frequency questionnaire (FFQ), which included the usual portion size, and the 24-hour dietary records (recall and record method) [13]. The diet record was used to verify the usual portion sizes of products using the product and food photography album [14]. The dietary patterns of pregnant women were identified using the k-means method based on product groups from the food frequency questionnaire. In accordance with adopted statistical procedure for identifying dietary patterns, an analysis was made of the grouping of products used in the diets of pregnant women at several levels of categorization in line with the grouping adopted in the Diet 6 dietary computer program. Then, the dimensions of the analysis were reduced using the factor analysis method, which allowed to reflect the acceptable level of overall variability. K-means clustering method was used to identify dietary patterns. Both the grouping parameters and the number of dietary patterns were analyzed in terms of quantitative parameters (group size) and qualitative parameters (interpretation possibilities). The standard is to identify 2–4 dietary patterns. The energy and nutritional value profile in the identified dietary patterns was also analysed using the Diet 6 nutritional computer programme [15]. The obtained results were compared with the current nutrition standards and medical standards [16–18].

Statistical analysis

The statistical analysis of the obtained results was performed using the IBM SPSS 21 statistical program. The median and quartile ranges were used to describe quantitative variables due to the lack of conformity of the distributions of variables with the normal distribution. $P < 0.05$ was adopted as the level of statistical significance. To assess the relationship between the diet and the nutritional status of pregnant women, Student's t-tests and analysis of variance were used for quantitative variables fulfilling the conditions of normal distribution and homogeneity of variance. Non-parametric Mann-Whitney and Kruskal-Wallis tests were used for quantitative variables that did not meet the conditions of normal distribution and homogeneity of variance. The Chi-square test of independence was used to analyse the body mass index (BMI) and weight gain as categorical variables. The principal component analysis with Quatrimax rotation, including Bartlett sphericity tests, and k-means cluster analysis were used to identify the dietary patterns of the studied women. The energy value and the share of individual components in the average daily food ration of the studied women were expressed in the form of the mean and standard deviation as well as the median and quartiles 1 and 3. The percentage of women whose nutrient intake was below the average requirement of the group (EAR) and above the adequate intake (AI) was also calculated.

RESULTS

Characteristics of the study group

The study involved 392 women. Table 2. presents the characteristics of the studied group. The vast majority of the respondents had completed higher education and were residents of large cities. Most of the women were in the third trimester of pregnancy.

Assessment of the nutritional status of the studied women

Table 3. presents the nutritional status of the studied women, determined using prepregnancy BMI. The appropriate BMI values before pregnancy were recorded in 76.3% of the examined women. Based on the data on the current body weight and the body weight before pregnancy, the mean weight gain of the studied pregnant women was calculated with reference to the prepregnancy BMI (tab. 4).

The mean weight gain during pregnancy was higher than recommended in all three subgroup. The highest mean gains were observed in the group of women with body weight deficiency before pregnancy (0.56 vs 0.51 kg/week), and the lowest in the group of women with excess body weight (0.40 vs 0.22–0.28 kg/week). In the group of women with appropriate body weight before pregnancy, the mean weight gain during pregnancy was 0.55 kg/week (norm 0.42 kg/week). There were statistically significant differences between the groups in the mean weight gain of pregnant women in relation to their prepregnancy BMI ($p < 0.05$).

Assessment of the diets

As a result of the cluster analysis, three dietary patterns of the studied pregnant women were identified. Figure 1 shows the distribution of the mean values for each cluster (dietary pattern).

The identified patterns were defined as follows:

Dietary pattern 1 – with predominance of cereal products and butter, rennet cheeses and fermented milk drinks, defined as the cereal-milk diet.

Dietary pattern 1 was characterised by high consumption of such products as cereals and butter, rennet cheeses and fermented milk drinks, as well as meat, poultry, cold cuts, and sugar. Dietary pattern 1 was characterized by low consumption of vegetables, including potatoes and fruit. Dietary pattern 1 was adhered to by 33.4% (n = 131) of the studied women.

Dietary pattern 2 with a definite predominance of vegetables, fruit and potatoes, was defined as the vegetable-fruit diet. Dietary pattern 2 was characterized by high consumption of vegetables, including potatoes and fruit. The consumption of cereal products and butter, meat, poultry and cold cuts exceeded the average consumption for the whole group, but less than the products from the vegetables group, including potatoes and fruit. Milk consumption was also slightly above the average. This pattern also involved low consumption of cottage cheese and rennet cheeses, fermented milk drinks and sugar. Dietary pattern 2 was adhered to by 21.7% (n = 85) of the studied women.

Dietary pattern 3 – with predominance of cottage cheese, as well as a higher than average consumption of fish and cooked vegetables was defined as the cottage cheese-vegetable diet. Dietary pattern 3 was characterized by high consumption of cottage cheese. The majority of the analysed product groups did not differ significantly from the average for the entire group, but the consumption of fish and cooked vegetable dishes as well as the consumption of milk deserve attention. However, in the consumption structure of the identified patterns, the consumption of fish did not differ significantly, therefore dietary pattern 3 was named the cottage cheese-vegetable diet. This pattern also involved significantly lower consumption of cereal products and butter as well as meat, poultry and cold cuts. Dietary pattern 3 was adhered to by 44.9% (n = 176) of the studied women. Table 5. presents the characteristics of the identified dietary patterns based on the product consumption structure.

Figure 2. shows the frequency of the identified dietary patterns in the subgroups of pregnant women in relation to their nutritional status determined using the BMI before pregnancy. The most frequent dietary pattern in all groups of women was pattern 3, defined as the cottage cheese-vegetable diet. There was no statistically significant relationship between the dietary patterns and prepregnancy body mass index (BMI). The frequency of dietary patterns depending on weight gain during pregnancy and BMI before pregnancy was also analysed (fig. 3).

Assessment of the frequency of dietary patterns depending
on the weight gain in pregnancy and the BMI before pregnancy

showed that dietary pattern 1 (cereal-milk diet) occurred most often in the group of women with excess body weight before pregnancy whose weight gain during pregnancy was above than recommended (75.0%). Dietary patterns 1 and 2 occurred most often in the group of women with underweight before pregnancy whose weight gain during pregnancy was in the line with the recommendations and above (40.0% and 53.8% respectively). In the group of women with appropriate body weight before pregnancy, a more even distribution of the identified patterns was observed.

Assessment of the nutrient profile in the identified dietary patterns

Table 6. shows the energy value and nutrient profile of three identified dietary patterns in pregnant women.

The cereal-milk diet (dietary pattern 1) had the highest energy value (Me = 2487.3 kcal). The energy value of the vegetable-fruit diet (dietary pattern 2) was similar (Me = 2446.5 kcal). The cottage cheese-vegetable diet had the lowest energy value (Me = 2055.2 kcal). In the case of the first two dietary patterns, these values were close to nutritional norms, while in the third pattern they were significantly lower. The impact of pregnancy on energy expenditure varies by trimester of pregnancy and varies among women, e.g. depending on pre-pregnancy body weight and gestational weight gain. According to recommendations, gestational weight gain should be taken into account when determining energy needs for pregnant women. Energy requirement may be different in women whose gestational weight gain should be lower or higher than average values [16]. The protein and fat content was similar, being the highest in pattern 1 where it amounted to 128.6 g for proteins and 75.0 g for fat, and the lowest in pattern 3 – 101.8 g for proteins and 63.4 g for fat. The protein content significantly exceeded the recommended values in all dietary patterns. The highest content of carbohydrates was recorded in the vegetable-fruit diet (dietary pattern 2) (Me = 344.0 g), slightly lower in the cereal-milk diet (dietary pattern 1) (Me = 313.6 g) and the lowest in the cottage cheese-vegetable diet (dietary pattern 3) (Me = 265.8). The content of most minerals exceeded the recommended values in all dietary patterns, it was lower only in the case of iron and iodine. In the cottage cheese-vegetable diet (dietary pattern 3), the content of all analysed minerals was the lowest. The analysis of the consumption of fat-soluble vitamins revealed that the amounts of vitamins A and E were higher than recommended in all clusters. All dietary patterns were characterized by a lower than recommended content of vitamin D, which was approximately 3 µg. The content of water-soluble vitamins was higher than recommended in all dietary patterns. The content of vitamin C exceeded the nutritional standards four times. The percentage of energy from proteins slightly exceeded the recommended values, and the percentage of energy from fat and carbohydrates was within the norms.

DISCUSSION

During the life cycle of a woman, pregnancy is the period when she is most open to changing her behaviour and lifestyle for the benefit of the child's development. Lifestyle changes include, among others, also the diet correction. The nutritional factor is therefore one of the most important determinants of the appropriate development of pregnancy and the child. Nutritional needs should be analysed individually for each patient, taking into account her age, level of physical activity, lifestyle and, above all, nutritional status [2, 5]. A rational diet during pregnancy prevents complications and ensures appropriate development of the fetus. The implementation of nutritional recommendations in practice consists in adhering to a balanced and varied diet, thus reducing the incidence of both deficiency and excess of energy and nutrients [4–6]. The increased demand for energy (2nd and 3rd trimester) should be fulfilled by increasing the intake of mainly milk and dairy products, lean meat and its products, fish and additional portions of vegetables and fruit [16].

Numerous studies emphasize that the main complication caused by maternal underweight may be low birth weight of the child, which is often associated with an increased risk of cardiovascular diseases and type 2 diabetes [19–24], whereas maternal overweight and obesity may adversely affect the course of pregnancy and the child's development by increasing the risk of preeclampsia, preterm labour and gestational diabetes. In the case of excess body weight in a pregnant woman, it is more often necessary to perform a caesarean section. Some research reports suggest that maternal overweight or obesity during pregnancy may increase the risk of obesity in a child in later life [25–32]. The nutritional status determined using prepregnancy BMI of the majority of women (76.3%) in our study was appropriate. To assess the nutritional status of the studied women during pregnancy, their weight gain in kg per week was calculated. In all subgroups, the weight gain was above the values recommended by the Institute of Medicine [12]. The highest average weight gain was recorded in the group of women who were underweight before pregnancy (0.56 vs 0.51 kg/week). Weight gain in women with an appropriate body mass index before pregnancy was on average 0.55 kg/week, which was 0.13 kg/week higher than recommended. The lowest average gains of 0.40 kg / week were observed in women with excess body weight before pregnancy, but they still exceeded the recommendations (0.22–0.28 kg/week). The literature describes extensively the relationship between abnormal weight gain in pregnancy and the risk of health complications, both in the mother and in the child [19–21, 23, 33, 34]. In the studied group of women who were underweight before pregnancy, body weight gains were higher than recommended and the highest in the entire group of women. This suggests that during pregnancy they changed their diet, ate larger amounts of food to provide all the necessary nutrients to the developing child. In the studied group of women with overweight and obesity, weight gain during pregnancy was the lowest, but still higher than recommended. This may mean that these women have a more conscious attitude towards the nutritional factor and pay more attention to the selection of products in their diet. Studies by Oken et al. suggest that weight gain in obese women which is lower than recommended has a positive effect on pregnancy outcomes, i.e. it reduces the risk of macrosomia in a child, the risk of premature birth, and even obesity in their offspring at the age of 3 years. [27]. At the same time, weight gain lower than the American guidelines should not be routinely recommended for obese pregnant women. These recommendations should be individualized, taking into account risk factors [35].

The nutritional status is related to the diet. The diets of different population groups can be assessed using various methods, one of them being the identification of dietary patterns, which has attracted an increasing attention in recent years. As a comprehensive method, it is used to determine the relationship between the diet and the nutritional status, which gives a more complete picture of the impact of consumption of various dietary components on health status indicators. In the Polish literature, dietary patterns of women during pregnancy have not been widely described, in contrast to foreign literature, where this topic is more popular. Dietary patterns of pregnant women are most often described in the context of the course of pregnancy, the risk of complications, including gestational diabetes, pregnancy-induced hypertension, birth weight of the newborn, and also in the long-term perspective, i.e. nutritional programming [36–40]. Researchers identifying dietary patterns try to indicate the pattern which is most similar to the nutritional recommendations for pregnant women and compare it with other patterns that significantly deviate from the recommendations. The dietary pattern compliant with the recommendations is most often described as healthy or prudent [41–44], but also health conscious [45]. Thus, defined dietary patterns are characterized by a high intake of vegetables, fruit, oils, whole grains and fish. The patterns which deviate from the recommendations are referred to as traditional or Western and are characterized by a high intake of red meat and its products, potatoes, sugar and sweets, cereal products, fat, except for olive oil, salty snacks, eggs, sauces and sweet drinks. For example, in a Canadian study of 1.545 pregnant women, four dietary patterns were identified. The first one, i.e. healthy pattern, was characterized by high intake of vegetables, including green vegetables, fruit, orange vegetables, oils, white and brown pasta, brown rice, fish and tomatoes. In the second one, named the meat and refined carbohydrates pattern, the more frequent intake of red meat, processed meat, fries, roast and boiled potatoes, and white bread was recorded. The third pattern was characterized by a high intake of beans and pulses, cheese, and vegetable salads and was named the beans, cheese and salad pattern. Women adhering to the fourth pattern named tea and coffee pattern more frequently drank coffee and tea, including with added reduced-fat milk, cream and sugar. The results showed that women adhering to healthy dietary patterns before pregnancy had a lower risk of developing complications such as hypertension [44]. In the Greek study, two dietary patterns were identified in pregnant women and named health conscious and Western. The Western pattern was characterised by a high intake of meat and meat products, potatoes, sugar and sweets, cereals, fats except olive oil, salty snacks, eggs, sauces and sweet beverages [45]. For the sake of comparison, in the Japanese study, the Western dietary pattern was described as a pattern with low intake of non-alcoholic beverages and sweets [46]. This shows that different dietary patterns may have the same names in different studies and vice versa. Some patterns, which were characterised by similar products in different studies, may be named differently. For example, there are many names for the pattern called the Mediterranean diet, such as the Mediterranean-type diet, the Mediterranean diet index, and the alternative Mediterranean diet, but the main components of this diet are the same [47–51]. A study conducted in 10 Mediterranean countries proved that adherence to the Mediterranean pattern of eating during pregnancy results in a better glucose tolerance and a lower incidence of gestational diabetes [51]. The authors of a Dutch prospective study proved that adherence to a traditional dietary pattern during pregnancy, in comparison with a Mediterranean pattern, has a negative impact on blood pressure parameters causing their increase [52]. In Denmark, the adherence to a Mediterranean dietary pattern by pregnant women was associated with a reduced risk of preterm labour [47]. A prospective study involving 13.110 American women showed that the Western dietary pattern was positively correlated with the risk of gestational diabetes, and the prudent dietary pattern, characterised by a high intake of fruit, green leafy vegetables, poultry and fish, showed a negative correlation [41]. Another study found that a prudent dietary pattern was associated with a lower risk of gestational diabetes, especially among women with excess body weight [43]. He et al. also proved that the dietary pattern defined as vegetable pattern was correlated with a lower risk, while the sweets and seafood pattern with a significantly higher risk of gestational diabetes mellitus [53]. It has also been shown that consumption of the DASH diet (high in fruit, vegetables, whole grain cereals, low-fat dairy products, and lower in saturated fat, cholesterol, and sodium 2400 mg/day) for 4 weeks by pregnant women had a beneficial effect on glucose tolerance and lipid profile compared to the control diet [54]. A Norwegian study has shown that pregnant women eating a diet with a high intake of vegetables and plant-based products, including oils, had a lower risk of pre-eclampsia, while a diet with a high intake of meat, sweet drinks and snacks increased this risk [55].

In our study, it can be concluded that none of the identified dietary patterns was fully compliant with the health-promoting pattern described in the current literature. Dietary pattern 1 defined as the cereal-milk diet seems to be the closest to the patterns described in the literature as traditional or Western, due to a high intake of cereals and butter, hard cheese, meat, poultry, cold cuts, and sugar and a low intake of vegetables and fruit. Dietary pattern 2 defined as the vegetable-fruit diet stood out due to the intake of this group of products, but at the same time it was characterized by a higher intake of potatoes, meat and poultry, and a lower intake of cottage cheese, rennet cheese and fermented milk drinks. Dietary pattern 3, defined as the cottage cheese-vegetable diet, was characterized by a higher intake of cottage cheese, as well as milk, cooked vegetables and fish, but also a lower intake of cereal products and butter, as well as meat, poultry and cold cuts.

The frequency of the identified dietary patterns in the three subgroups of the studied women, depending on their pre-pregnancy body mass index, was similar. The differences were slight and statistically insignificant. It should be noted, however, that the most common pattern was dietary pattern 3 defined as the cottage cheese-vegetable diet with the lowest energy value. The analysis of the frequency of individual patterns in the studied women depending on the weight gain during pregnancy revealed a greater differentiation. Dietary pattern 1, i.e. the cereal-milk diet with higher energy value occurred most often in the group of women with excess bodyweight before pregnancy whose weight gain during pregnancy was above the recommendations (75.0%). It means that they should pay more attention to their diet during pregnancy due to the higher risk of complications related to excess body weight in pregnancy. Dietary patterns 1, i.e. the cereals-milk diet and dietary pattern 2, i.e. vegetable-fruit diet occurred most often in the group of women with underweight before pregnancy whose weight gain during pregnancy was in the line with the recommendations and above (40.0% and 53.8% respectively). It is possible that women in this group, who were slim before pregnancy, paid more attention to their diet during pregnancy.

The study has several strengths. All data regarding the diets of studied pregnant women were collected by one qualified person, and verified with the product and food photography album [14], which reduces the risk of incorrect estimation of the size of the consumed portions of food. The study focused on the identification of dietary patterns as a comprehensive method used to determine the relationship between the diet and nutritional status. Diet pattern analysis is considered as a holistic, alternative and complementary approach to assessing the relationship between diet and chronic disease risk by assessing the impact of the overall diet and its complexity. Therefore, the analysis of dietary patterns can be helpful in evaluating dietary recommendations and in explaining the relationship between the consumption of individual dietary components and health when these relations may depend on the dietary pattern. Moreover, the identification of dietary patterns of pregnant women can be the basis for shaping educational programs in childbirth classes. In the literature, there are only few studies describing the dietary patterns of Polish women during pregnancy

[56, 57]. Only our study includes the nutrient profile of identified feeding patterns of pregnant women.

However, this study also has limitations. The group of studied pregnant women is not representative, but it is a large sample (n=392). The studied women are participants of childbirth classes, mostly with higher education. Despite this, the results of the conducted research suggest the need for educational activities in the field of healthy eating patterns during pregnancy.

CONCLUSIONS

Although pregnancy should not differentiate the dietary procedures, including the selection of products, different dietary patterns were identified. In each group of women, regardless of their nutritional status before pregnancy as determined by BMI, the percentage of women adhering to the identified patterns was similar. In the studied women, weight gain during pregnancy was higher than in recommendations/guidelines, being the highest in women who were slim before pregnancy, and lower in women with excess body weight, which was related to their dietary patterns. The method of analysing the nutritional management through identified dietary patterns of pregnant women, correlated with their weight gain, can be a fast and effective way to convince this group of women to adjust their diets for the benefit of the health of the mother and the child, as well as for long-term prediction of the risk of diet-related disease in adulthood of the child. The analysis of the dietary patterns of pregnant women who are participants of childbirth education classes may be helpful in education and modification of the dietary recommendations for this population group, also with regard to supplementation.

Article information and declarations

Data availability statement

All data generated or analyzed during this study are included in this article. The datasets are not publicly available but are available from the corresponding author on reasonable request.

Ethics statement

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of the Institute of Mother and Child (Opinion No 10/2019).

Author contributions

Małgorzata Więch Corresponding author, concept, methodology, acquisition of data, analysis and interpretation of data, visualization, manuscript writing, editing and approval the final manuscript. Ewa Kawaik-Jawor Data curation, formal analysis methodology, visualization, review, editing and approval the final manuscript. Marta Barańska Writing original draft, review and approval the final manuscript. Julia Zaręba-Szczudlik Revised article critically. Halina Weker Concept, methodology, writing original draft, review and approval the final manuscript.

Consent for publication

Informed consent was obtained from all participants of the study.

Funding

None.

Conflict of interest

The authors declare that they have no competing interests.

REFERENCES

1. Schwarzenberg SJ, Georgieff MK. COMMITTEE ON NUTRITION. Advocacy for Improving Nutrition in the First 1000 Days to Support Childhood Development and Adult Health. Pediatrics. 2018; 141(2), doi: 10.1542/peds.2017-3716, indexed in Pubmed: 29358479.

2. Moreno-Fernandez J, Ochoa JJ, Lopez-Frias M, et al. Impact of Early Nutrition, Physical Activity and Sleep on the Fetal Programming of Disease in the Pregnancy: A Narrative Review. Nutrients. 2020; 12(12), doi: 10.3390/nu12123900, indexed in Pubmed: 33419354.

3. Del Castillo-Matamoros SE, Poveda NE. Importance of nutrition in pregnant women. Rev Colomb Obstet Ginecol. 2021; 72(4): 339–345, doi: 10.18597/rcog.3825, indexed in Pubmed: 35134281.

4. Scherer-Adami F, Dutra-Rosolen M, Schedler F, et al. Nutritional status and dietary intake of pregnant women. Rev Salud Publica (Bogota). 2020; 22(1): 27–33, doi: 10.15446/rsap.V22n1.72795, indexed in Pubmed: 36753136.

5. Grenier LN, Atkinson SA, Mottola MF, et al. Be Healthy in Pregnancy: Exploring factors that impact pregnant women's nutrition and exercise behaviours. Matern Child Nutr. 2021; 17(1): e13068, doi: 10.1111/mcn.13068, indexed in Pubmed: 32705811.

6. Marshall NE, Abrams B, Barbour LA, et al. The importance of nutrition in pregnancy and lactation: lifelong consequences. Am J Obstet Gynecol. 2022; 226(5): 607–632, doi: 10.1016/j.ajog.2021.12.035, indexed in Pubmed: 34968458.

7. Harrison CL, Teede H, Khan N, et al. Weight management across preconception, pregnancy, and postpartum: A systematic review and quality appraisal of international clinical practice guidelines. Obes Rev. 2021; 22(10): e13310, doi: 10.1111/obr.13310, indexed in Pubmed: 34312965.

8. Most J, Dervis S, Haman F, et al. Energy Intake Requirements in Pregnancy. Nutrients. 2019; 11(8), doi: 10.3390/nu11081812, indexed in Pubmed: 31390778.

9. Wirfält E, Drake I, Wallström P. What do review papers conclude about food and dietary patterns? Food Nutr Res. 2013; 57, doi: 10.3402/fnr.v57i0.20523, indexed in Pubmed: 23467387.

10. Wądołowska L. Zasady obliczania i interpretacji wyników w: Gronowska-Senger A. [red.] Przewodnik metodyczny badań sposobu żywienia. Komitet Nauki o Żywieniu Człowieka Polskiej Akademii Nauk, Warszawa; 2013; 57-65. https://www.researchgate.net/publication/271645174_Zasady_obliczania_i_interpretacji_wynikow.

11. Hu FB. Dietary pattern analysis: a new direction in nutritional epidemiology. Curr Opin Lipidol. 2002; 13(1): 3–9, doi: 10.1097/00041433-200202000-00002, indexed in Pubmed: 11790957.

12. Weight Gain During Pregnancy. 2009, doi: 10.17226/12584.

13. Jagtap S. Codesign in Low Resource Settings. Design and Engineering for Low Resource Settings. 2024: 31–45, doi: 10.1007/978-3-031-66156-3_3.

14. Szponar L, Wolnicka K, Rychlik E. Album fotografii produktów i potraw. Instytut Żywności i Żywienia, Warszawa; 2000.

15. Wajszczyk B, Chwojnowska Z, Nasiadko D, Rybaczuk M. Program Dieta 6 do planowania i bieżącej oceny żywienia indywidualnego. Instytut Żywności i Żywienia, Warszawa; 2021. https://www.pzh.gov.pl/wp-content/uploads/2022/02/Instrukcja-korzystania-z-Diety-6.0-2021.pdf (publication in polish).

16. Jarosz M, Rychlik E, Stoś K, Charzewska J. [ed.] Normy żywienia dla populacji Polski i ich zastosowanie. Narodowy Instytut Zdrowia Publicznego – Państwowy Zakład Higieny, Warszawa 2020. https://www.pzh.gov.pl/wp-content/uploads/2020/12/Normy_zywienia_2020web-1.pdf.

17. Dietary Reference Values for nutrients Summary report. EFSA Supporting Publications. 2017; 14(12), doi: 10.2903/sp.efsa.2017.e15121.

18. Zimmer M., Sieroszewski P., Oszukowski P., Huras H., Fuchs T., Pawłosek A. Rekomendacje Polskiego Towarzystwa Ginekologów i Położników dotyczące suplementacji u kobiet ciężarnych. Ginekologia i Perinatologia Praktyczna 2020;5:170-181. https://www.ptgin.pl/sites/scm/files/2022-01/07.2020 - Rekomendacje Polskiego Towarzystwa Ginekologów i Położników dotyczące suplementacji u kobiet ciężarnych_0.pdf.

19. Davis RR, Hofferth SL, Shenassa ED. Gestational weight gain and risk of infant death in the United States. Am J Public Health. 2014; 104 Suppl 1(Suppl 1): S90–S95, doi: 10.2105/AJPH.2013.301425, indexed in Pubmed: 24354832.

20. Galjaard S, Pexsters A, Devlieger R, et al. The influence of weight gain patterns in pregnancy on fetal growth using cluster analysis in an obese and nonobese population. Obesity (Silver Spring). 2013; 21(7): 1416–1422, doi: 10.1002/oby.20348, indexed in Pubmed: 23408453.

21. Hunt KJ, Alanis MC, Johnson ER, et al. Maternal pre-pregnancy weight and gestational weight gain and their association with birthweight with a focus on racial differences. Matern Child Health J. 2013; 17(1): 85–94, doi: 10.1007/s10995-012-0950-x, indexed in Pubmed: 22322428.

22. Goldstein RF, Abell SK, Ranasinha S, et al. Association of Gestational Weight Gain With Maternal and Infant Outcomes: A Systematic Review and Meta-analysis. JAMA. 2017; 317(21): 2207–2225, doi: 10.1001/jama.2017.3635, indexed in Pubmed: 28586887.

23. Zhao R, Xu L, Wu ML, et al. Maternal pre-pregnancy body mass index, gestational weight gain influence birth weight. Women Birth. 2018; 31(1): e20–e25, doi: 10.1016/j.wombi.2017.06.003, indexed in Pubmed: 28716548.

24. Goldstein RF, Abell SK, Ranasinha S, et al. Gestational weight gain across continents and ethnicity: systematic review and meta-analysis of maternal and infant outcomes in more than one million women. BMC Med. 2018; 16(1): 153, doi: 10.1186/s12916-018-1128-1, indexed in Pubmed: 30165842.

25. Hedderson MM, Weiss NS, Sacks DA, et al. Pregnancy weight gain and risk of neonatal complications: macrosomia, hypoglycemia, and hyperbilirubinemia. Obstet Gynecol. 2006; 108(5): 1153–1161, doi: 10.1097/01.AOG.0000242568.75785.68, indexed in Pubmed: 17077237.

26. Stotland NE, Cheng YW, Hopkins LM, et al. Gestational weight gain and adverse neonatal outcome among term infants. Obstet Gynecol. 2006; 108(3 Pt 1): 635–643, doi: 10.1097/01.AOG.0000228960.16678.bd, indexed in Pubmed: 16946225.

27. Oken E, Taveras EM, Kleinman KP, et al. Gestational weight gain and child adiposity at age 3 years. Am J Obstet Gynecol. 2007; 196(4): 322.e1–322.e8, doi: 10.1016/j.ajog.2006.11.027, indexed in Pubmed: 17403405.

28. Poston L. Gestational weight gain: influences on the long-term health of the child. Curr Opin Clin Nutr Metab Care. 2012; 15(3): 252–257, doi: 10.1097/MCO.0b013e3283527cf2, indexed in Pubmed: 22406744.

29. Catalano P, deMouzon SH. Maternal obesity and metabolic risk to the offspring: why lifestyle interventions may have not achieved the desired outcomes. Int J Obes (Lond). 2015; 39(4): 642–649, doi: 10.1038/ijo.2015.15, indexed in Pubmed: 25777180.

30. Langley-Evans SC. Nutrition in early life and the programming of adult disease: a review. J Hum Nutr Diet. 2015; 28 Suppl 1: 1–14, doi: 10.1111/jhn.12212, indexed in Pubmed: 24479490.

31. Tebbani F, Oulamara H, Agli A. Effects of gestational weight gain on pregnancy complications. Nutrition Clinique et Métabolisme. 2018; 32(1): 27–32, doi: 10.1016/j.nupar.2017.09.011.

32. Szamotulska K. [red.] Przeprowadzenie kompleksowych badań epidemiologicznych dotyczących sposobu żywienia i stanu odżywienia kobiet ciężarnych wraz z identyfikacją czynników ryzyka zaburzeń odżywiania, oceną poziomu aktywności fizycznej, poziomu wiedzy żywieniowej oraz występowania nierówności w zdrowiu. Raport końcowy z badania 2017-2020. Instytut Matki i Dziecka. Warszawa; 2020. https://archiwum.mz.gov.pl/zdrowie-i-profilaktyka/narodowy-program-zdrowia/poprawa-sposobu-zywienia-stanu-odzywienia-oraz-aktywnosci-fizycznej-spoleczenstwa/3-1-przeprowadzenie-kompleksowych-badan-epidemiologicznych-dotyczacych-sposobu-zywienia-i-stanu-odzywienia-kobiet-ciezarnych-wraz-z-identyfikacja-czynnikow-ryzyka-zaburzen-odzywiania-ocena-poziomu/.

33. Krukowski RA, Bursac Z, McGehee MA, et al. Exploring potential health disparities in excessive gestational weight gain. J Womens Health (Larchmt). 2013; 22(6): 494–500, doi: 10.1089/jwh.2012.3998, indexed in Pubmed: 23751164.

34. Faucher MA, Barger MK. Gestational weight gain in obese women by class of obesity and select maternal/newborn outcomes: A systematic review. Women Birth. 2015; 28(3): e70–e79, doi: 10.1016/j.wombi.2015.03.006, indexed in Pubmed: 25866207.

35. Kapadia MZ, Park CK, Beyene J, et al. Can we safely recommend gestational weight gain below the 2009 guidelines in obese women? A systematic review and meta-analysis. Obes Rev. 2015; 16(3): 189–206, doi: 10.1111/obr.12238, indexed in Pubmed: 25598037.

36. Chen X, Zhao D, Mao X, et al. Maternal Dietary Patterns and Pregnancy Outcome. Nutrients. 2016; 8(6), doi: 10.3390/nu8060351, indexed in Pubmed: 27338455.

37. Raghavan R, Dreibelbis C, Kingshipp BL, et al. Dietary patterns before and during pregnancy and birth outcomes: a systematic review. Am J Clin Nutr. 2019; 109(Suppl_7): 729S–756S, doi: 10.1093/ajcn/nqy353, indexed in Pubmed: 30982873.

38. da Mota Santana J, de Oliveira Queiroz VA, Pereira M, et al. Associations between Maternal Dietary Patterns and Infant Birth Weight in the NISAMI Cohort: A Structural Equation Modeling Analysis. Nutrients. 2021; 13(11), doi: 10.3390/nu13114054, indexed in Pubmed: 34836305.

39. Kebbe M, Flanagan EW, Sparks JR, et al. Eating Behaviors and Dietary Patterns of Women during Pregnancy: Optimizing the Universal 'Teachable Moment'. Nutrients. 2021; 13(9), doi: 10.3390/nu13093298, indexed in Pubmed: 34579175.

40. Schwedhelm C, Lipsky LM, Temmen CD, et al. Eating Patterns during Pregnancy and Postpartum and Their Association with Diet Quality and Energy Intake. Nutrients. 2022; 14(6), doi: 10.3390/nu14061167, indexed in Pubmed: 35334823.

41. Zhang C, Schulze MB, Solomon CG, et al. A prospective study of dietary patterns, meat intake and the risk of gestational diabetes mellitus. Diabetologia. 2006; 49(11): 2604–2613, doi: 10.1007/s00125-006-0422-1, indexed in Pubmed: 16957814.

42. Englund-Ögge L, Brantsæter AL, Sengpiel V, et al. Maternal dietary patterns and preterm delivery: results from large prospective cohort study. BMJ. 2014; 348: g1446, doi: 10.1136/bmj.g1446, indexed in Pubmed: 24609054.

43. Tryggvadottir EA, Medek H, Birgisdottir BE, et al. Association between healthy maternal dietary pattern and risk for gestational diabetes mellitus. Eur J Clin Nutr. 2016; 70(2): 237–242, doi: 10.1038/ejcn.2015.145, indexed in Pubmed: 26350393.

44. Jarman M, Mathe N, Ramazani F, et al. APrON and ENRICH study teams. Dietary Patterns Prior to Pregnancy and Associations with Pregnancy Complications. Nutrients. 2018; 10(7), doi: 10.3390/nu10070914, indexed in Pubmed: 30018227.

45. Chatzi L, Melaki V, Sarri K, et al. Dietary patterns during pregnancy and the risk of postpartum depression: the mother-child 'Rhea' cohort in Crete, Greece. Public Health Nutr. 2011; 14(9): 1663–1670, doi: 10.1017/S1368980010003629, indexed in Pubmed: 21477412.

46. Miyake Y, Okubo H, Sasaki S, et al. Maternal dietary patterns during pregnancy and risk of wheeze and eczema in Japanese infants aged 16-24 months: the Osaka Maternal and Child Health Study. Pediatr Allergy Immunol. 2011; 22(7): 734–741, doi: 10.1111/j.1399-3038.2011.01176.x, indexed in Pubmed: 21539616.

47. Mikkelsen TB, Osterdal ML, Knudsen VK, et al. Association between a Mediterranean-type diet and risk of preterm birth among Danish women: a prospective cohort study. Acta Obstet Gynecol Scand. 2008; 87(3): 325–330, doi: 10.1080/00016340801899347, indexed in Pubmed: 18307073.

48. Haugen M, Meltzer HM, Brantsaeter AL, et al. Mediterranean-type diet and risk of preterm birth among women in the Norwegian Mother and Child Cohort Study (MoBa): a prospective cohort study. Acta Obstet Gynecol Scand. 2008; 87(3): 319–324, doi: 10.1080/00016340801899123, indexed in Pubmed: 18307072.

49. Tobias DK, Hu FB, Chavarro J, et al. Healthful dietary patterns and type 2 diabetes mellitus risk among women with a history of gestational diabetes mellitus. Arch Intern Med. 2012; 172(20): 1566–1572, doi: 10.1001/archinternmed.2012.3747, indexed in Pubmed: 22987062.

50. Tobias DK, Zhang C, Chavarro J, et al. Prepregnancy adherence to dietary patterns and lower risk of gestational diabetes mellitus. Am J Clin Nutr. 2012; 96(2): 289–295, doi: 10.3945/ajcn.111.028266, indexed in Pubmed: 22760563.

51. Timmermans S, Steegers-Theunissen RPM, Vujkovic M, et al. Major dietary patterns and blood pressure patterns during pregnancy: the Generation R Study. Am J Obstet Gynecol. 2011; 205(4): 337.e1–337.12, doi: 10.1016/j.ajog.2011.05.013, indexed in Pubmed: 21855845.

52. He JR, Yuan MY, Chen NN, et al. Maternal dietary patterns and gestational diabetes mellitus: a large prospective cohort study in China. Br J Nutr. 2015; 113(8): 1292–1300, doi: 10.1017/S0007114515000707, indexed in Pubmed: 25821944.

53. Asemi Z, Tabassi Z, Samimi M, et al. Favourable effects of the Dietary Approaches to Stop Hypertension diet on glucose tolerance and lipid profiles in gestational diabetes: a randomised clinical trial. Br J Nutr. 2013; 109(11): 2024–2030, doi: 10.1017/S0007114512004242, indexed in Pubmed: 23148885.

54. Brantsaeter AL, Haugen M, Samuelsen SO, et al. A dietary pattern characterized by high intake of vegetables, fruits, and vegetable oils is associated with reduced risk of preeclampsia in nulliparous pregnant Norwegian women. J Nutr. 2009; 139(6): 1162–1168, doi: 10.3945/jn.109.104968, indexed in Pubmed: 19369368.

55. Wesołowska E, Jankowska A, Trafalska E, et al. Sociodemographic, Lifestyle, Environmental and Pregnancy-Related Determinants of Dietary Patterns during Pregnancy. Int J Environ Res Public Health. 2019; 16(5), doi: 10.3390/ijerph16050754, indexed in Pubmed: 30832307.

56. Association between Bone Mineral Density and Dietary Patterns in Elderly Women in Guangxi: A Cross-Sectional Study in China. International Journal of Frontiers in Medicine. 2024; 6(5), doi: 10.25236/ijfm.2024.060511.

Table 1. The number of course participants and collected questionnaires

Year of the study	Number of courses*	Number of participants in 4 courses	Number of collected questionnaires
2012	4	112	76
2013	4	116	70
2014	4	112	60
2015	4	120	54
2016	4	112	51
2017	4	120	75
2018	4	104	62
7 years	28	796 (100%)	448 (56%)

*A maximum of 30 women could participate in one course due to practical classes and exercises

Table 2. Characteristics of the studied group

Variables	Pregnant women (n = 392) n (%)
Women's age [years]	
• 19	1 (0.3)
• 20–30	205 (52.3)
• 31–40	186 (47.4)
Place of residence	
• city ≥ 100 tys.	366 (93.4)
• town < 100 tys.	18 (4.6)
• village	8 (2.0)
Education	
• lower than secondary	1 (0.3)
• secondary	46 (11.7)
• higher	345 (88.0)

Trimester of pregnancy • 2nd trimester • 3rd trimester	 137 (35.0) 255 (65.0)

Table 3. Prepregnancy BMI of the studied women

Variables	Studied group of women (n = 392) n (%)
Prepregnancy BMI [kg/m^2]	
• < 18.5	43 (10.9)
• 18.5–24.9	299 (76.3)
• 25.0–29.9	40 (10.2)
• ≥ 30.0	10 (2.6)

Table 4. Average weight gain of the studied women depending on prepregnancy BMI

Prepregnancy BMI [kg/m^2]	Average weight gain in pregnancy [kg/week]					Recommended weight gain according to Institute of Medicine (2009)	p
	$\bar{x}$	SD	Me	1Q–3Q	min–max		
Body weight deficiency: BMI ≤ 18.5	0.56	0.17	0.55	0.44–0.68	0.27–1.00	0.51	0.000
Normal body weight: BMI 18.5–24.9	0.55	0.20	0.53	0.43–0.65	–0.05–1.27	0.42	
Excess body weight: BMI ≥ 25.0	0.40	0.25	0.43	0.25–0.56	–0.21–1.08	0.22–0.28	

$\bar{x}$ – mean, SD – standard deviation, Me – median, 1Q–3Q – 1 quartile–3 quartile, min–max – range minimum–maximum, Kruskal-Wallis p < 0,005

Table 5. Characteristics of the identified dietary patterns based on the product consumption structure

Group of products [g]	**Dietary pattern 1(A)** cereal-milk diet	**Dietary pattern 2(B)** vegetable-fruit diet	**Dietary pattern 3(C)** cottage cheese-vegetable diet	p**
	¯x ± SD*** (Me, Q1–Q3)*			
Cereals (in terms of flour)	192.1 ± 64.1 $^{B, C}$ (192.4, 146.2–223.9)	166.2 ± 70.7 $^{A, C}$ (148.0, 119.0–201.7)	117.9 ± 52.2 $^{A, B}$ (117.5, 79.7–148.0)	0.000
Milk	145.1 ± 114.5 (140.0, 70.0–250.0)	161.3 ± 136.5 (140.0, 70.0–250.0)	160.6 ± 145.4 (140.0, 70.0–250.0)	0.736
Fermented milk drinks	185.0 ± 144.0 (143.0, 85.0–250.0)	183.5 ± 147.2 (150.0, 85.0–280.0)	189.3 ± 143.9 (152.5, 85.0–280.0)	0.910
Cottage-cheese (in terms of milk)	352.5 ± 278.7 ^{B} (335.0, 201.0–402.0)	243.8 ± 183.9 $^{A, C}$ (201.0, 113.9–402.0)	360.3 ± 327.2 ^{B} (288.1, 154.1–452.3)	0.011
Rennet cheese	45.6 ± 25.7 $^{B, C}$ (40.0, 34.0–60.0)	21.5 ± 19.0 ^{A} (17.0, 6.0–35.0)	16.3 ± 11.3 ^{A} (11.0, 11.0–23.0)	0.000
Meat and poultry	219.6 ± 100.0 ^{C} (206.0, 158.0–273.0)	218.8 ± 91.6 ^{C} (218.0, 171.0–285.0)	156.6 ± 78.9 $^{A, B}$ (158.0, 103.0–206.0)	0.000
Cold cuts	55.0 ± 32.1 48.6, (28.0–80.4)	38.2 ± 31.9 (39.1, 10.3–51.5)	24.9 ± 21.8 (20.7, 6.5–42.6)	0.000
Fish and seafood	47.9 ± 37.6 (60.0, 0.0–60.0)	46.9 ± 36.0 (60.0, 0.0–60.0)	48.7 ± 37.2 (60.0, 0.0–60.0)	0.891
Butter and cream	20.8 ± 9.9 $^{B, C}$ (20.0, 15.0–25.0)	16.3 ± 10.4 $^{A, C}$ (15.0, 10.0–20.0)	10.4 ± 8.2 $^{A, B}$ (10.0, 3.0–16.0)	0.000
Vegetables and fruits	659.2 ± 263.9 $^{B, C}$ (599.8, 475.9–808.4)	1030.4 ± 420.8 $^{A, C}$ (989.7, 671.3–1355.7)	795.2 ± 353.6 $^{A, B}$ (775.3, 556.1–947.6)	0.000
Cooked vegetables	60.9 ± 69.9 ^{C} (43.0, 0.0–100.0)	90.4 ± 90.7 (80.0, 0.0–150.0)	83.2 ± 85.8 ^{A} (60.0, 10.0–128.0)	0.025
Cooked potatoes	92.4 ± 56.1 $^{B, C}$ (85.0, 60.0–115.0)	198.4 ± 69.2 $^{A, C}$ (170.0, 150.0–250.0)	64.6 ± 45.3 $^{A, B}$ (60.0, 43.0–85.0)	0.000
Sugar	16.4 ± 13.2 $^{B, C}$ (11.0, 6.0–23.0)	11.9 ± 10.9 ^{A} (11.0, 6.0–17.0)	12.3 ±10.3 ^{A} (11.0, 6.0–17.0)	0.006

* x ± SD (Me, Q1–Q3) – mean ± standard deviation (median; 1 quartile–3 quartile)

** statistically significant differences in the consumption of groups of products between the three clusters of the studied women (Kruskal-Wallis; p < 0,005)

*** statistically significant differences between clusters of studied women A, B, C calculated using a post hoc test (multiple two-sided comparisons)

Table 6. Comparison of energy value and nutrient profile of the three dietary patterns with the nutritional recommendations

Energy and nutrients	**Dietary pattern 1 (A)** cereal-milk diet			**Dietary pattern 2 (B)** vegetable-fruit diet			**Dietary pattern 3 (C)** cottage cheese-vegetable die	
	$\bar{x}$ ± SD**	Me	1Q–3Q	$\bar{x}$ ± SD**	Me	1Q–3Q	$\bar{x}$ ± SD**	Me
Basic nutrients								
Energy [kJ]	10645.7 ± 1982.4 C	10423.5	9437.8–11560.9	10716.8 ± 2074.3 C	10271.0	9240.0–12138.4	8581.8 ± 1810.4 A, B	8637.9
Energy [kcal]	2531.8 ± 470.9 C	2487.3	2243.1–2743.9	2547.3 ± 493.1 C	2446.5	2197.5–2882.9	2040.3 ± 430.6 A,B	2055.2
Total protein [g]	135.2 ± 29.6 C	130.9	115.5–151.4	128.1 ± 28.9 C	128.6	111.5-144.9	104.4 ± 26.7 A,B	101.8
Animal protein [g]	102.5 ± 27.1 C	97.8	85.1–114.6	91.,4 ± 25.9 C	90.5	78.1–106.7	76.8 ± 25.2 A,B	74.7
Plant-based protein [g]	32.3 ± 8.1 B,C	31.0	25.8–37.0	36.1 ± 10.3 A,C	34.6	30.0–40.8	26.9 ±7.3 A,B	26.8
Fat [g]	84.2 ± 18.0 B,C	81.9	71.0–96.8	75.8 ± 18.5 A,C	75.0	62.5–88.6	64.0 ± 17.7 A,B	63.4
Cholesterol [mg]	380.0 ± 103.1 C	371.2	304.9–449.8	349.5 ± 117.0 C	348.7	258.6–400.1	287.7 ± 97.2 A, B	266.8
Saturated faty acids [g]	33.3±7.5	32.4	28.4–37.8	26.9 ± 8.1 C	27.3	22.1–32.0	22.2 ± 6.8 B	22.0
Monounsaturated fatty acids [g]	31.8 ± 8.2 C	30.6	25.8–37.2	29.3 ± 8.9 C	28.7	23.7–34.1	24.8 ± 8.1 A, B	24.3
Polyunsaturated fatty acids [g]	13.1 ± 4.5	12.4	10.0–15.5	13.8 ± 4.6	13.8	10.8–16.8	12.4 ± 5.4	11.3
Linoleic acid [g]	9.6 ± 3.3 C	8.9	7.2–11.1	10.0 ± 3.3 C	9.6	7.8–12.0	8.7 ± 4.1 A,B	7.8
α-linolenic acid [g]	2.3 ± 0.9	2.1	1.7–2.7	2.4 ± 0.9	2.4	1.7–3.0	2.3 ± 1.4	2.0
Long chain polyunsaturated fatty acids [g]	1.0 ± 1.1	0.3	0.1–2.0	1.1 ± 1.2	0.3	0.1–2.1	1.2 ± 1.3	0.3
Omega 3 fatty acids[g]	3.4 ± 1.7	3.0	2.1–4.4	3.6 ± 1.8	3.4	2.1–4.7	3.5 ± 2.1	3.4
Omega 6 fatty acids[g]	9.8 ± 3.4 C	9.1	7.3–11.4	10.2 ± 3.3 C	9.8	8.0–12.3	8.9 ± 4.1 A, B	7.9
Docosaheksaenoic acid (DHA) [g]	0.7 ± 0.7	0.2	0.1–1.3	0.7 ± 0.8	0.2	0.1–1.3	0.8 ± 0.8	0.2
Eicosapentaenoic acid (EPA) [g]	0.2 ± 0.2	0.1	0.0–0.4	0.3 ± 0.3	0.1	0.0–0.4	0.3 ± 0.3	0.1
Carbohydrates [g]	323.3 ± 75.5 B, C	313.6	273.5–360.5	355.5 ± 82.7 A, C	344.0	302.9–401.0	275.5 ± 68.9 A, B	265.8
Saccharose [g]	57.6 ± 26.2	52.6	40.7–71.2	63.1 ± 28.3 C	57.6	43.9–76.2	53.9 ± 25.2 B	50.9
Lactose [g]	16.2 ± 9.1	16.1	9.6–20.7	15.7 ± 9.3	15.2	9.8–20.7	16.5 ± 9.0	15.6
Glucose [g]	16.9 ± 7.7 B	15.7	11.7–20.2	24.8 ± 11.2 A,C	23.0	17.0–33.3	18.2 ± 7.6 B	17.0
Fructose [g]	22.8 ± 10.12 B	20.7	15.7–27.4	31.4 ±13.0 A,C	31.2	21.6–40.6	23.8 ± 10.2 B	21.7
Starch [g]	155.9 ± 45.7 C	148.7	124.0–181.5	156.5 ± 53.5 C	156.5	123.5–179.1	111.0 ± 37.3 A, B	110.6
Fibre [g]	29.8 ± 8.9 B	28.7	22.6–36.5	34.2 ± 10.9 A,C	33.0	25.5–42.2	27.1 ± 8.6 B	26.3
Minerals								

Sodium [mg]	3383.1 ± 719.0 C	3244.5	2876.3–3899.7	3231.0 ± 846.3 C	3158.8	2647.1–3787.0	2358.6 ± 615.3 A, B	2332.4
Potassium [mg]	4743.9 ± 1058.2 B,C	4492.2	4023.5–5424.8	5799.2 ± 1307.6 A,C	5608.7	4901.9–6579.0	4400.4 ± 1068.5 A, B	4310.6
Calcium [mg]	1290.5 ± 424.5 B, C	1278.2	999.2–1515.5	1156.7 ± 387.1 A	1174.8	923.0–1337.9	1091.2 ± 336.7 A	1098.3
Phosphorus [mg]	2115.2 ± 465.7 C	2035.5	1822.2–2405.1	2042.1 ± 437.0 C	2090.7	1780.7–2239.4	1723.9 ± 446.5 A, B	1654.5
Magnesium [mg]	462.0 ± 102.4 B, C	454.7	388.5–521.0	510.3 ± 108.5 A,C	500.7	430.6–554.9	410.2 ± 95.0 A, B	406.1
Iron [mg]	14.8 ± 3.5 C	14.7	12.2–16.8	16.1 ± 4.1 C	15.8	13.5–18.4	12.7±3.2 A,B	12.6
Zinc [mg]	16.0 ± 3.5 C	15.8	13.4–18.5	14.9 ± 3.3 C	14.8	12.4–16.8	12.7 ± 3.1 A,B	12.0
Copper [mg]	1.5 ± 0.4 B,C	1.5	1.3–1.8	1.8 ± 0.5 A,C	1.8	1.5–2.2	1.4 ± 0.4 A,B	1.4
Manganese [mg]	7.4 ± 2.6 C	7.4	5.4–8.9	7.1 ± 2.4 C	7.1	5.3–8.4	6.2 ± 2.4 A,B	5.9
Iodine [µg]	127.6 ± 42.9 B, C	122.8	99.9–152.9	147.3 ± 43.5 A,C	140.3	119.7–170.0	113.7±39.1 A,B	111.1
Fat soluble vitamins								
Vitamin A (retinol equvalent) [µg]	1344.9 ± 729.8	1191.0	819.5–1660.1	1424,4 ± 831,1	1207,1	834.3–1758.3	1206.6 ± 665.2	1085.1
Retinol [µg]	493.0 ± 219.0 B, C	454.0	374.0–547.5	395.6 ± 207.3 A, C	373.9	283.4–459.8	336.9 ± 151.1 A,B	313.1
B–carotene [µg]	5112.5 ± 4303.2	4143.7	2010.8–7018.9	6157.9 ± 4693.7	4840.7	2651.9–7965.8	5216.8 ± 3819.1	4298.3
Vitaminum E [mg]	13.0 ± 4.2 B	12.5	10.0–15.1	**15.** ± 5.4 A, C	14.5	11.6–18.1	12.6 ± 4.4 B	12.2
Vitaminum D [µg]	5.7 ± 4.6	3.1	1.8–9.5	5.8 ± 4.8	3.0	1.7–9.2	5.9 ± 5.2	3.5
Water soluble vitamins								
Vitaminum B_1 [mg]	2.0 ± 0.4 C	1.9	1.7–2.2	2.1 ± 0.6 C	2.0	1.8–2.4	1.6 ± 0.4 A,B	1.6
Vitaminum B_2 [mg]	2.5 ± 0.6 C	2.4	2.1–2.9	2.5 ± 0.6 C	2.5	2.1–2.8	2.2 ± 0.6 A,B	2.1
Vitaminum PP [mg]	31.1 ± 9.8 C	29.5	24.7–35.2	33.1 ± 9.7 C	32.8	26.9–38.9	24.1 ± 7.3 A,B	23.8
Vitaminum B_6 [mg]	3.2±0.8 B,C	3.1	2.7–3.7	3.8 ± 1.0 A,C	3.8	3.2–4.4	2.9 ± 0.8 A,B	2.8
Vitaminum C [mg]	208.7 ± 115.6 B,C	182.2	111.5–266.0	315.1 ± 172.6 A,C	300.7	189.5–386.9	245.6 ± 128.0 A,B	228.0
Folates [µg]	398.1 ± 103.5 B	398.4	321.8–458.4	477.7 ± 149.3 A,C	452.3	351.2–575.6	387.4 ± 109.9 B	376.9
Vitaminum B_{12} [µg]	6.7 ± 2.5 C	6.4	4.8–8.1	6.4 ± 2.8	5.8	4.5–7.7	6.0 ± 2.6 A	5.7
Percentage of energy from basic nutrients								
Energy from protein [%]	21.7 ± 3.3 B	21.3	19.5–23.6	20.4 ± 3.4 A	21.3	19.5–23.6	20.8 ± 3.8	20.7
Energy from fat [%]	29.7 ± 4.2 B, C	29.3	27.1–31.5	26.5 ± 4.5 A	29.3	27.1–31.5	27.9 ± 5.1 A	27.9
Energy from carbohydrates [%]	46.4 ± 5.1 B, C	46.5	43.2–49.8	50.5 ± 5.8 A	46.5	43.2–49.8	48.8 ± 6.2 A	48.6
Other								
Caffeine [mg]	133.9 ± 82.4	110.0	91.5–170.0	123.1 ± 79.8	110.0	91.5–170.0	121.8 ± 81.0	110.0

$\bar{x}$ ± SD – mean ± standard deviation, Me – median, 1Q–3Q – 1 quartile – 3 quartile

p – statistically significant differences in energy and nutrients intakes between dietary patterns (Kruskal–Wallis $p < 0.05$)

EAR – Estimated Average Requirement, AI – Adequate Intake

*for women weighing 65 kg, ≥ 30 years fat requirement is assumed 49–86 g, at the level of physical activity PAL = 1.6 [nutritional standards for Poland] [16]

** statistically significant differences between clusters of studied women A,B,C calculated using a post hoc test (multiple two–sided comparisons)

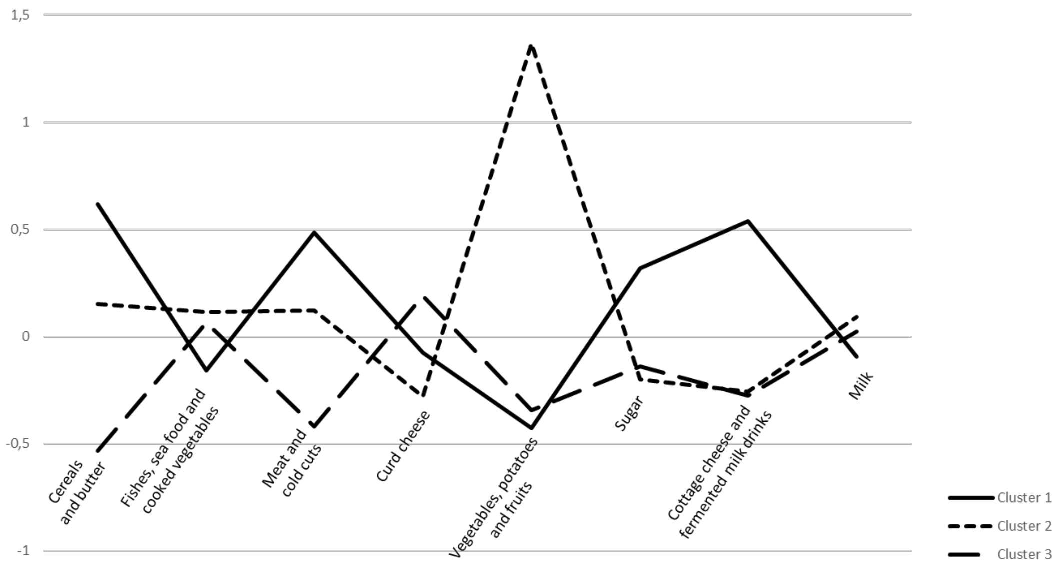
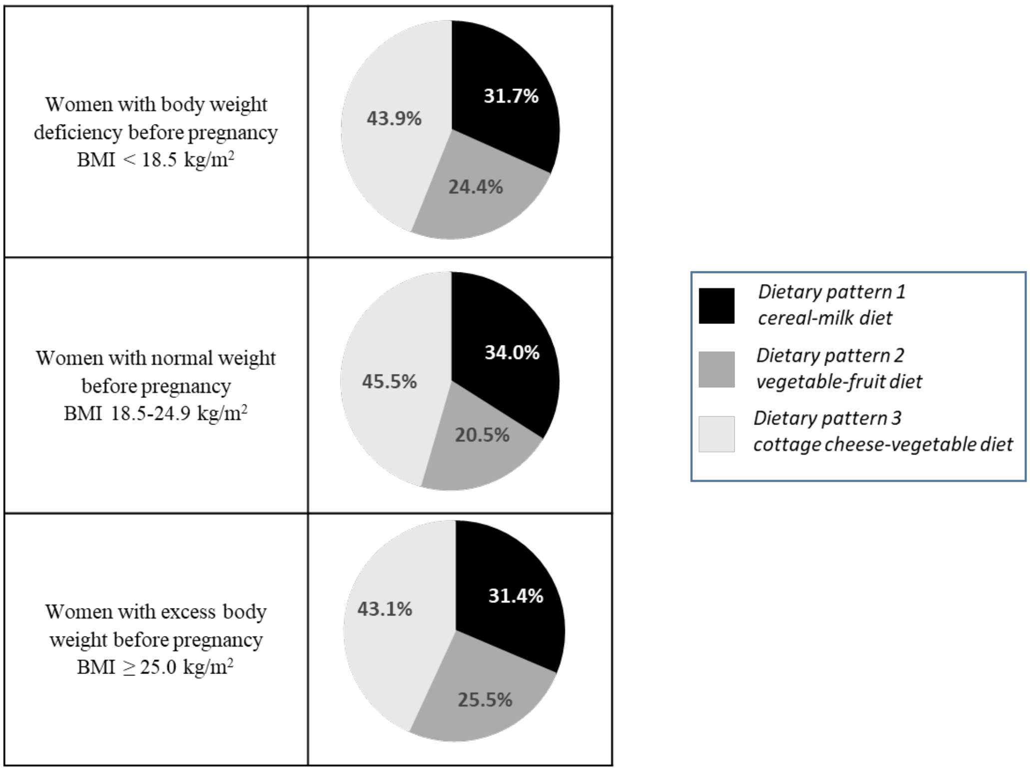


Figure 1. Distribution of mean values of the three identified clusters (dietary patterns) in the studied group of women



p = **.931,?** $Chi^2 = 0.855$

Figure 2. The frequency of the identified dietary patterns in the subgroups of pregnant women in relation to their nutritional status determined using the prepregnancy BMI

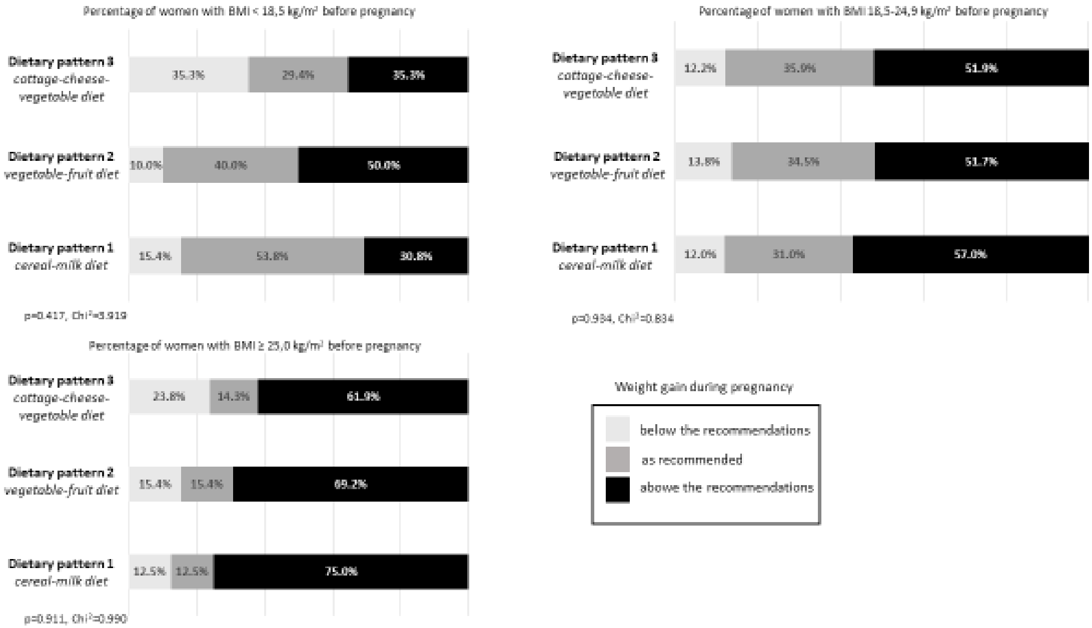


Figure 3. Frequency of dietary patterns depending on weight gain during pregnancy and prepregnancy BMI