ORIGINAL ARTICLE

# KNOWLEDGE OF YOUNG WOMEN ABOUT NUTRIENTS INFLUENCING DEVELOPMENT OF FETAL NERVOUS SYSTEM

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## ABSTRACT

**The aim:** To analyze the nutritional knowledge of women in the reproductive age about nutrients influencing the fetal nervous system's development.

**Materials and methods:** The study was conducted with a proprietary anonymous questionnaire using the CAWI (Computer Assisted Web Interviews) method among 263 women aged 18-51 years.

**Results:** In 35.4% of the surveyed women, the level of knowledge was insufficient, in 31.9% – sufficient, in 27% – good, and only in 5.7% – very good. The knowledge of the respondents was influenced by education ($p < 0.001$) and body mass index (BMI, $p < 0.001$). Women of reproductive age with higher education and/or lower BMI had a better understanding of nutrients influencing the fetal nervous system's development. Age, place of residence, family status, and professional status did not affect their knowledge.

**Conclusions:** The study showed that it is necessary to conduct nutritional education among women of reproductive age. Increasing the respondents' awareness of the importance of nutrients determining the fetus's proper development, both during the reproductive period and during pregnancy, is extremely important.

**KEY WORDS:** women of reproductive age, pregnancy, nervous system, fetus, nutrients

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## INTRODUCTION

One of the most important factors influencing the proper development of the fetal nervous system is women's nutrition, both during pre-conception and during pregnancy. The diet should be based on the principles of rational nutrition in accordance with the latest recommendations developed by the Food and Nutrition Institute presented in the Healthy Nutrition Pyramid. When planning a diet, one should consider the energy demand and contents of carbohydrates, proteins, and fats [1].

Improper eating habits, as well as both too low and too high body weight, increase the risk of certain diseases, such as type 2 diabetes and arterial hypertension. Numerous studies were carried out to prove the importance of the phenomenon of nutritional programming. Developing proper eating habits in women during the procreation period determines, among other things, the correct course of pregnancy, reduces the risk of perinatal complications, and also conditions the development of the fetus and then the child in adulthood. The supply of vitamins and minerals in women of reproductive age, according to the current needs, is important in the development of the fetus's nervous system from conception. Nutrients that should be given special attention include vitamin D, iodine, iron, folic acid, and omega-3 polyunsaturated fatty acids. A proper, balanced diet in the pre-conception period enables the accumulation of essential nutrients and their effective use by the developing fetus. On the other hand, the inclusion of physical activity in accordance with the World Health Organization (WHO) recommendations allows one to maintain a healthy body weight. According to the latest recommendations, an adult should perform moderate physical activity for at least 150 minutes a week or intense exercise for a minimum of 75 minutes a week [2].

According to the latest recommendations of the Polish Gynecological Society of 2017, one should supplement folic acid for three months before a planned pregnancy and increase the consumption of food products that are its source. These include dry legume seeds, dark green leafy vegetables (Brussels sprouts, lettuce, spinach, broccoli), as well as liver. An increased risk of a fetus's neural tube defect and a cleft lip and palate in the newborn is one of the consequences of a folate deficiency in pregnancy. Several risk groups were taken into account, determining the recommended folic acid supplementation dose. The high-risk group includes women with certain gastrointestinal diseases, such as ulcerative colitis, celiac disease or Crohn's disease, carbohydrate metabolism disorders, including type 1 or 2 diabetes, insulin resistance, and diagnosed polycystic ovary syndrome. Some groups of drugs, such as antiepileptics or metformin, affect the metabolism of folic acid. Women with a history of alcoholism or smoking are at higher risk, which in turn is associated with the need to increase the dose of folic acid to 0.8 mg/day, taking into account active folates. In obese women, as well as after bariatric surgeries, attention should be paid to folate supplementation at a dose of 0.8

mg/day. Another risk factor predisposing to increasing the dose of folic acid to 0.8 mg/day is the MTHFR gene mutation. On the other hand, in women with diagnosed neural tube defects in their offspring, mother or father, the recommended dose of supplementation should be 5 mg/day, taking into account active folates, 12 weeks before the planned pregnancy, and also during the first and second trimesters [3-8].

Due to the increased risk of anemia in pregnancy, iron is the second essential nutrient. The demand for this micronutrient rises to 27 mg/day in pregnancy [9]. Even though the absorption of iron with food is only 10% – 15%, it is worth enriching the diet with products that are its source. These include dry seeds of legumes, red meat, and liver [9]. The consequence of the deficiency of this element in pregnancy is the occurrence of anemia. The effects of untreated anemia include increased risk of premature delivery, cesarean section, postpartum hemorrhage, or giving birth to a child with low body weight [10].

Another important micronutrient is iodine. It affects the thyroid gland's proper functioning and determines the production of the hormones: triiodothyronine and thyroxine. The demand in women of reproductive age is 150 μg/day, while during pregnancy, it increases to 250 μg/day [11]. Due to its widespread deficiency in society, it has been ordered to enrich table salt with iodine since 1997. Sea fish such as cod, salmon, and pollock, as well as rennet cheeses, are its main source in the diet. Currently, a frequently used practice in the food industry is the enrichment of mineral waters with iodine. When planning a menu during pregnancy, it is essential to remember about the existence of goitrogens, which reduce the absorption of iodine from food, while disturbing the production of thyroid hormones. These include cabbage, soy, turnips, broccoli, and cauliflower [12]. Adequate supply in line with the current needs reduces the risk of hypothyroidism in pregnancy, miscarriage, intrauterine fetal death, or premature birth [13].

Currently, due to the widespread deficiency of vitamin D in Polish society, the Polish Society of Gynecologists and Obstetricians recommends a dose of 2000 IU/day for women of reproductive age, as well as during pregnancy and breastfeeding. Consequences of insufficient supply include the development of pre-eclampsia, gestational diabetes, and an increased risk of premature delivery or having a low birthweight child [14, 15]. The effect of vitamin D deficiency for the fetus is the possibility of an enamel defect in childhood and skeletal mineralization deterioration [16].

Due to the fact that polyunsaturated fatty acids are a building component of the myelin sheaths of synaptic membranes, it is worth paying attention to their adequate supply. One of the most essential acids belonging to the group of omega-3 polyunsaturated fatty acids is docosahexaenoic acid (DHA). Its source is fatty sea fish and seafood, but when planning a pregnant woman's diet, it should be noted that some products that are the source of DHA may have potentially adverse health consequences. In 2010, guidelines were published not to recommend marine fish for pregnant women, such as smoked sprats, tuna, shark, and swordfish. A proper supply of omega-3 fatty acids reduces the risk of postpartum depression and determines the fetus's growth [17].

Pregnancy is a period of many changes taking place in a woman's body. Therefore, caring for its proper course, as well as the development of a child, one should take into account components that are of particular importance for the development of the fetal nervous system. When planning a diet, it is worth noting that the energy demand also increases in the second trimester by 360 kcal and by 475 kcal in the third trimester of pregnancy.

## THE AIM

The study aimed nutritional knowledge of women of reproductive age about nutrients influencing the fetal nervous system's development.

## MATERIALS AND METHODS

The survey was carried out using the CAWI method (Computer Assisted Web Interviews) in the period from March to May 2020. The questionnaire consisted of single-choice questions concerning knowledge about the nutrients required for the proper development of the fetal nervous system as well as concerning sociodemographic data, including questions about education, professional status, place of residence, age, height, and body weight.

Inclusion criteria for the study were: female gender, age 18-51, informed consent to participate. Exclusion criteria were as follows: male gender, pregnancy, lactation period, female age under 18 and over 51. Women's knowledge was assessed using the proprietary point scale. For each correct answer, the respondents obtained 1 point, and for incorrect or no answers, the respondents obtained 0 points. A maximum of 18 points could be obtained. The following grading scale was adopted: 16-18 points – very good; 13-15 points – good; 10-12 points – satisfactory grade; 0-9 points – insufficient grade.

The last question in the proprietary questionnaire concerned the subjective assessment of one's own knowledge about the nutrients for the fetal nervous system's proper development.

The obtained results were processed with the use of Microsoft Office Excel. Statistical analysis was performed using the Statistica 13 software. Measurable data were characterized using the mean (X) and standard deviation (SD), while nominal data were presented as percentages. The Kolmogorov-Smirnov test was used to check whether a given distribution meets the condition of a normal distribution. Non-parametric tests were applied when compared variables did not meet the requirement of normal distribution. The significance of differences in the results between the two groups was tested using the Mann-Whitney U test. The significance of differences in the results between more than two groups was checked using the Kruskal-Wallis test.

**Table 1.** The sociodemographic analysis of the surveyed women.

| | | Number | [%] |
|---|---|---|---|
| Place of residence | Rural area | 56 | 21.4 |
| | Town: < 50 thousand residents | 43 | 16.4 |
| | Town: 50-100 thousand residents | 35 | 13.4 |
| | City: > 100 thousand residents | 128 | 48.9 |
| Education | Primary | 2 | 0.8 |
| | Vocational | 6 | 2.3 |
| | Secondary | 80 | 30.5 |
| | Higher | 174 | 66.4 |
| Employment status | Pupil/student | 50 | 19.0 |
| | Student and professionally active | 47 | 17.9 |
| | Professionally active | 149 | 56.7 |
| | Unemployed | 17 | 6.5 |
| Social status | Single | 84 | 31.9 |
| | In a partnership/marriage | 179 | 68.1 |

Further post hoc testing was checked by multiple pairwise comparisons, and significance levels were corrected by the Bonferroni method. Correlations between the variables were checked using the Spearman correlation coefficient. The level of significance was $p < 0.05$.

## RESULTS

Two hundred sixty-three women aged 18-51 participated in the study. The mean age of the respondents was 28 years ± 6.62 years, mean body weight – 65.4 ± 13.2 kg, mean height – 167 ± 6.39 cm, while the mean BMI value was 23.4 ± 4.26 kg/m$^2$. The respondents with normal body weight constituted 64% of the respondents, followed by 7% of underweight women, 23% – overweight, and 6% – obese.

The sociodemographic analysis of the surveyed women is presented in Table 1.

Answers to questions about the knowledge of nutrients influencing the development of the fetus's nervous system are summarized in Table 2.

For each correct answer, the respondents obtained 1 point, and for incorrect or no answer – 0 points. The maximum number of points possible to earn was 18.

The examined women obtained an average of 10.6 ± 3.35 points. At least half of the respondents gave no more than 11 correct answers. Most often, the respondents were able to provide 13 answers correctly (33 people). Two respondents did not answer any of the questions correctly, and one person answered all the questions correctly.

Based on the obtained number of correct answers, the level of knowledge about nutrients influencing the development of the nervous system of the fetus was determined. 35.4% of women obtained an insufficient grade, 31.9% – satisfactory, 27% – good, and only 5.7% – very good.

There was no statistically significant relationship between the level of knowledge about nutrients influencing the development of the nervous system of the fetus and age ($p = 0.676$), place of residence ($p = 0.685$), employment status ($p = 0.093$), or family status (single or partnership) ($p = 0.057$).

However, a statistically significant relationship between BMI and the level of knowledge was demonstrated. The respondents who obtained high BMI values gave less correct answers ($p < 0.001$).

Moreover, a statistically significant relationship was found between the level of education and the level of knowledge. The respondents who had a higher education level provided more correct answers to the questions asked ($p < 0.001$).

The correlation made with the Spearman rank coefficient showed a statistically significant relationship between the self-assessment of knowledge and the level of knowledge about nutrients influencing the fetal nervous system's development. The respondents who stated that their self-esteem in the discussed topic was high, provided more correct answers to the questions asked ($r = 0.49$; $p < 0.001$).

## DISCUSSION

Knowledge about preventive nutritional activities in women of reproductive age was the subject of research by many specialists. One of the most important factors in maintaining full health is using a properly balanced diet, in line with the current energy needs and the inclusion of physical activity. An adequate supply of nutrients not only prevents the consequences of their deficiency in reproductive age but also ensures the proper course of pregnancy. In order to provide the appropriate development of the fetus, with particular emphasis on the nervous system, one should ensure the correct supply of vitamin D, iodine, iron, polyunsaturated fatty acids, and folic acid.

**Table 2.** Answers to the survey questions concerning the nutritional knowledge of women of reproductive age in the field of nutrients influencing the fetal nervous system's development.

| | | Number of responses | [%] |
|---|---|---|---|
| Which of the listed minerals must be supplemented during pregnancy? | Calcium, magnesium, vitamin D | 13 | 5.0 |
| | Vitamin C, E, zinc | 4 | 1.5 |
| | Calcium, vitamin D | 3 | 1.1 |
| | Folic acid, vitamin D* | 241 | 92.3 |
| What time before a planned pregnancy should folic acid be supplemented according to the Polish Gynecological Society's latest recommendations? | 4 weeks | 33 | 12.7 |
| | 8 weeks | 70 | 26.9 |
| | 12 weeks* | 133 | 51.2 |
| | 16 weeks | 24 | 9.2 |
| What are the sources of folate in food? | Green leafy vegetables and whole grains* | 230 | 88.1 |
| | Milk and dairy products | 2 | 0.8 |
| | Meat and fish | 17 | 6.5 |
| | Fruit and vegetables rich in beta-carotene | 12 | 4.6 |
| What might be the effects of a folate deficiency in pregnancy? | Fetal vision and hearing defects | 25 | 9.7 |
| | Fetal neural tube defects* | 166 | 64.1 |
| | Deterioration of the psychomotor and cognitive development of the fetus | 57 | 22.0 |
| | Cretinism and hypothyroidism | 11 | 4.2 |
| Which of the listed ingredients increase folate absorption? | Iodine and vitamin D | 77 | 30.1 |
| | Iron, zinc, and vitamin C* | 88 | 34.4 |
| | Magnesium, zinc, and vitamin E | 25 | 9.8 |
| | Phosphorus, calcium, and vitamin D | 66 | 25.8 |
| How much vitamin D should be supplemented according to the latest recommendations? | 400 IU/day | 44 | 16.9 |
| | 800 IU/day | 55 | 21.2 |
| | 2000 IU/day* | 147 | 56.5 |
| | 4000 IU/day | 14 | 5.4 |
| Which of the following ingredients have the most significant impact on the development of the fetal nervous system? | Vitamin C, E, and magnesium | 4 | 1.5 |
| | Vitamin D, omega-3 fatty acids, iron, and folic acid* | 167 | 64.2 |
| | Folic acid, chlorine, phosphorus, and vitamin C | 23 | 8.8 |
| | Iron, calcium, omega-3 fatty acids and vitamin K | 66 | 25.4 |
| What are the sources of vitamin D in food? | Dark green leafy vegetables | 27 | 10.4 |
| | Fruits | 9 | 3.5 |
| | Oily sea fish* | 182 | 70.3 |
| | Legume seeds | 41 | 15.8 |
| What are the effects of iron deficiency in pregnancy on the fetus? | Cretinism and hypothyroidism | 24 | 9.3 |
| | Low birthweight* | 122 | 47.5 |
| | Development of metabolic disorders | 86 | 33.5 |
| | Increased risk of bone fractures | 25 | 9.7 |
| Which component might be vastly deficient in women who are menstruating profusely before pregnancy? | Calcium | 9 | 3.5 |
| | Magnesium | 13 | 5.0 |
| | Iron* | 225 | 86.9 |
| | Iodine | 12 | 4.6 |
| What are the effects of iodine deficiency on the woman and the fetus? | Hypothyroxinemia, the development of attention deficit hyperactivity (ADHD)* | 49 | 19.1 |
| | Megaloblastic anemia, lower intelligence quotient (IQ) in childhood | 39 | 15.2 |
| | Hypothyroxinemia, increased fracture frequency | 41 | 16.0 |
| | Cretinism accompanied by hypothyroidism, visual impairment | 128 | 49.8 |
| Which component deficiency can cause hypothyroxinemia? | iron | 20 | 7.8 |
| | zinc | 37 | 14.5 |
| | iodine* | 180 | 70.3 |
| | magnesium | 19 | 7.4 |

| | | | |
|---|---|---|---|
| What are the sources of iodine in the diet? | Dark green leafy vegetables | 26 | 10.0 |
| | Fish and seafood* | 215 | 83.0 |
| | Fruits | 9 | 3.5 |
| | Whole-grain cereal products | 9 | 3.5 |
| What is the sufficient sodium intake for women of reproductive age?? | less than 0.5 g/day | 67 | 26.2 |
| | 1.5 g/day* | 141 | 55.1 |
| | 4 g/day | 46 | 18.0 |
| | more than 6 g/day | 2 | 0.8 |
| Which products inhibit iodine absorption due to the content of goitrogens? | Milk and dairy products | 59 | 23.1 |
| | Turnips, broccoli, Brussels sprouts, and cabbage* | 98 | 38.4 |
| | Pepper, tomato, parsley, and peach | 24 | 9.4 |
| | Orange, grapefruit, and lemon | 74 | 29.0 |
| The demand for which ingredient increases significantly during pregnancy? | Magnesium | 58 | 22.7 |
| | Zinc | 14 | 5.5 |
| | Iodine* | 72 | 28.1 |
| | Calcium | 112 | 43.8 |
| What are the sources of omega-3 fatty acids in the diet? | Milk and dairy products | 4 | 1.6 |
| | Whole-grain cereal products | 10 | 3.9 |
| | Rapeseed oil, olive oil, walnuts, and linseed* | 204 | 79.4 |
| | Sunflower oil, peanuts, evening primrose oil | 39 | 15.2 |
| Which medical conditions can cause a lower IQ and impaired speech development and cretinism? | Hypothyroidism* | 124 | 48.4 |
| | Iron deficiency anemia | 45 | 17.6 |
| | Vitamin $B_{12}$ deficiency anemia | 71 | 27.7 |
| | Diabetes and insulin resistance | 16 | 6.3 |
| Self-assessment of knowledge about the nutrients influencing the development of the fetal nervous system | Insufficient | 95 | 36.7 |
| | Satisfactory | 100 | 38.6 |
| | Good | 59 | 22.8 |
| | Very good | 5 | 1.9 |

*the correct answer

In 2017, Kamińska K, Zegan M, and Michota-Kotulska E researched women of reproductive age to test their knowledge about folic acid's role in pregnancy. Respondents knew the effects of folate deficiency, but they did not know what the recommended dose was in pregnancy and were not able to list the sources of folic acid in food products. Based on the above results, it was concluded that the respondents' knowledge was insufficient [18].

In 2015, Grzelak T. et al. conducted a study in which the respondents were divided into two groups. The first group consisted of 49 women planning pregnancy within the next year or pregnant women. The second group consisted of 205 adults. The mean age was 28.91 ± 5.05 years in the first group and 30.29 ± 11.81 years in the second group. The aim was to evaluate the supplements used among women of reproductive age planning to become pregnant or already pregnant women using an anonymous proprietary survey. 69.39% of pregnant women or women planning to become pregnant in the next 12 months declared regular or occasional intake of dietary supplements. In the second group, the same procedure was reported by 54.66% of the respondents. The use of supplementation was demonstrated in 56% of women of reproductive age planning pregnancy and as much as 89% of pregnant women [19]. Similar studies were conducted in 2008. The aim was to evaluate the consumption of vitamins and nutrients among 60 women from the Mazowieckie voivodeship in the reproductive age. The mean age of the respondents was 26.9 ± 4.2 years. As many as 75% of the respondents belonged to the age group of 21 – 30 years, 15% of women were over 30 years, and only 10% were under 20 years of age. The results were similar to the study conducted by Grzelak T et al. The use of supplements concerned 98.3% of pregnant women and 55% of women planning a pregnancy. There was a higher than the recommended intake of specific vitamins, such as vitamin D (157%), folic acid (128%), iodine and zinc (113%), and iron (120%.). Insufficient supply was found in the case of magnesium, calcium, and vitamin A. Most often, supplements were taken in the form of multi-component preparations. In the case of single-ingredient supplements, folic acid was most often used. In the conducted study, only every fifth woman showed a change in diet during pregnancy, of which 10% of the respondents introduced an easily digestible diet [20].

Pieszko M, Ciesielska-Piotrowicz J, Skotnicka M, and Małgorzewicz S conducted studies in which they examined the level of knowledge of women with higher and secondary education about proper eating habits influencing the development of the fetus. An anonymous questionnaire with 22 questions was used. The survey was divided into two parts. The first part consisted of a record, while the second part contained questions about the number

of meals, consumed food products, supplementation, feeling hungry, as well as the consumption of vegetables, fruit, sweets, and stimulants (coffee, alcohol, cigarettes). The authors assessed in the study the knowledge on the sources of folic acid and iron, as well as the recommended weight gain during pregnancy and physical activity. 58.1% of the surveyed women were in the 21 – 30 age group. In the studied group, the majority of the respondents were women who visited them for the first-time pregnancy, and constituted 86% of the respondents. 84% of respondents showed greater interest in proper eating habits during pregnancy. As many as 98% of women increased the consumption of vegetables and fruits, while 41.9% of the respondents increased the consumption of sweets during pregnancy. The most commonly used supplements were multi-component pharmaceutical preparations. 90.7% of women knew consequences of folic acid deficiency during pregnancy, while in our own work – only 64.1%. Most of the respondents in the study by Pieszo M et al. were women who were pregnant, while our own work did not take into account the respondents' experiences resulting from motherhood. 83.7% of the respondents knew the answer regarding the sources of folate in food. In our study, similar results were obtained – the correct answer was indicated by 88.1% of the respondents. One of the reasons for the knowledge of the effects of insufficient supply of folic acid is the introduction of the Primary Neural Tube Defects Prevention Program in 1997, which aimed to increase knowledge in the studied area [21].

Gieratka-Czernel M et al. researched 100 women between 5-38 weeks of pregnancy in Mazowieckie voivodship, of which 45% of the respondents were pregnant for the first time. Only every third respondent supplemented iodine, and 59% of women used food enriched with this element. In this study, only every 5th respondent knew the effects of iodine deficiency in pregnancy, which constituted 19.1% (n = 49). The results of the research by Gieratka-Czernel M et al. are consistent with our results [22].

In a study conducted by Pieczyńska J et al., nutrition was assessed using an anonymous proprietary questionnaire and a 24-hour interview from 7 consecutive days. The aim was to determine the relationship between pregnancy advancement and the intake of fatty acids with food and dietary supplements. The study involved 119 female residents of the Lower Silesia Province, who were divided into three groups according to the stage of pregnancy. The first group consisted of 79 women in the first trimester of pregnancy, the second group consisted of 54 women and the third group of 44 respondents. The study showed insufficient fat consumption in the various trimesters of pregnancy, while the average consumption was at the level of 29%, which was in line with the norms. Overly high consumption of saturated fatty acids was also shown.

In the presented conclusions, it was stated that the supply of particular groups of fatty acids is insufficient, both with food and in the form of dietary supplements. Simultaneously, it was shown that the consumption of fish increases and fried food consumption decreases in the next trimesters of pregnancy, which was a positive phenomenon. Women showed a willingness to change their eating habits during pregnancy, but no significant differences in the supply of particular groups of fatty acids were noted. One of the proposed solutions was the introduction of nutritional education among women of reproductive age in order to increase knowledge and awareness of proper eating habits [23].

## CONCLUSIONS

1. In more than one-third of the surveyed women of reproductive age, the level of knowledge in the field of nutrients influencing the development of the nervous system in the fetus was insufficient, while only in slightly more than half – sufficient or good.
2. Body mass index and education were the factors influencing the nutritional knowledge of the surveyed women. Women of reproductive age with higher education and/or lower BMI had a better understanding of nutrients influencing the fetal nervous system's development.
3. Age, place of residence, family status, and professional status did not significantly impact the nutritional knowledge of women of reproductive age.
4. The conducted research indicates the need for nutritional education, led by specialists among women of reproductive age, on nutrients influencing the development of the nervous system in the fetus.

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**Conflict of interest**

*The Authors declare no conflict of interest.*

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