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Pregnant women's diets and fatty acid intake - a study of the frequency of intake of products that are sources of fatty acids among women in the third trimester of pregnancy

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ABSTRACT:
Background: Polyunsaturated fatty acids, essential for the human body, have several positive functions that affect human health. Pregnancy is a time of particular demand for these acids, especially DHA and EPA, whose sources are mainly oily marine fish. The supply of adequate amounts of these acids conditions the proper development of the fetus, influencing, among other things, the formation of the central nervous system and the development of the child's retina, as well as protecting against premature birth and increasing the child's birth weight. The aim of the study was to assess the frequency of consumption of fish, vegetable oils, and products rich in polyunsaturated fatty acids and evaluate DHA supplementation by pregnant women, as well as to assess knowledge of PFAs, especially DHA and EPA. Material and methods: 210 pregnant women were included in the study. A self-administered and online survey questionnaires were used as the research tool. A database was created using Microsoft Excel.
Results: According to the recommended amounts, 2-3 times a week, Marine fish was consumed by only 12.86% of the women surveyed. Regular consumption of ALA-rich products, such as flaxseed, was declared by 10 respondents, while 59.05% of the surveyed women did not consume it at all. The use of DHA acid supplementation during pregnancy was unequivocally declared by 58 women surveyed, representing only ¼ of the women surveyed.
Conclusions: The dietary behavior of pregnant women related to fish consumption is not correct, the overall proportion of fish in the diet of the subjects does not cover the recommended amounts. Vegetable oils and products rich in PFAs are not consumed with adequate frequency by pregnant women. DHA supplementation by pregnant women, despite low fish consumption, is underestimated and at a very low level.

Keywords: Polyunsaturated fatty acids, omega-3, fish, DHA, EPA, intake assessment, pregnant women

1. INTRODUCTION

Pregnancy is a time of particular vulnerability of a woman's body, for which it is important to prepare accordingly. The choices made by the mother-to-be, including her nutritional behavior, greatly influence the proper preparation for pregnancy, its course, as well as the postpartum period, and the health and development of the child in the future [1,2]. A properly balanced diet, covering the needs for all macronutrients and micronutrients, including fats, can significantly improve the state of life and health of the woman and the child, as well as minimize any risks that are inherent to the period of pregnancy [1,2]. Adequate nutrition not only ensures the model nutritional status of the pregnant woman but above all influences the far-reaching effects of so-called 'nutritional programming', which describes the relationship between the nutrition of the mother-to-be and the normal development of the fetus and the quality of life of the child in the future [3].
Fats should cover between 20 and 35% of the daily energy requirements in a pregnant woman's diet. The main source of these should be vegetable oils and fish fats, which are a reservoir of essential fatty acids, including polyunsaturated fatty acids of the omega-3 family, the demand for which increases during pregnancy to ensure the proper development of the fetus.

Saturated fatty acids, on the other hand, should be consumed at as low a level as possible and make up a maximum of 10% of daily energy intake [3,4,5]. The requirement for polyunsaturated fatty acids varies according to age group, physiological state, and health status. It increases during pregnancy, lactation, and people suffering from cardiovascular disease and lipid metabolism disorders. An all-day diet should include products providing both n-3 and n-6 acids because the precursors of both families of these acids have a reciprocal effect on the number of metabolites contained in body tissues [4]. Based on the recommendations of the National Centre for Nutrition Education, the daily supply of DHA + EPA acids, during pregnancy and lactation, should be 250 mg/day + 100 - 200 mg DHA/day [4]. According to the recommendations of the Polish Gynaecological Society, in pregnant women whose intake of fish and other sources of DHA is at a very low level, supplementation with 500 mg of DHA per day is recommended starting from the first month of pregnancy [1]. On the other hand, the position of the Expert Group is that pregnant and lactating women should be supplemented with a minimum of 200 mg DHA per day, which should be increased to 400- 600 mg DHA per day with low fish consumption. DHA-only supplementation is indicated due to the plasma increase of this acid in cord blood, which will ensure optimal values of this component in the mother's body and proper distribution to the fetus [6]. Pregnant women at high risk of preterm birth should provide a minimum of 1,000 mg of DHA per day throughout pregnancy [1, 7].

Polyunsaturated fatty acids have many diverse functions in the human body. Fatty acids are the basic building blocks of phospholipids and cholesterol esters, serving to build the cell membrane of cells, tissues, and organs, as well as some biologically active substances. The presence of omega acids in the cell membrane increases its fluidity, which in turn ensures proper cell function [8,9].

Docosahexaenoic acid (DHA) is an essential component for building cell membranes of brain neurons in the central nervous system. It is also the main building block for the cell membranes of rods and cones in the retina, which are responsible for night vision and color discrimination [10]. To a lesser extent, it is found in sperm, erythrocytes, spleen, liver, and muscle. Depending on the organ, DHA content exceeds EPA levels in the tissue [11]. DHA plays a huge role in the development of the nervous system, which starts as early as during fetal life and continues into early and late childhood. The greatest accumulation of DHA within the CNS occurs after 20 weeks of gestation, between 26 and 40 weeks when CNS development is most intense and continues until 4 years of age. DHA is transported across the maternal placenta to the fetus, and the amount depends on the content of this acid in the pregnant woman's diet, which is why meeting the requirement for this EFA plays such an important role in the nutrition of mothers-to-be [10,12,13]. Adequate intake or supplementation of DHA during pregnancy results in a high content of this acid in the brain and retina, which in turn influences the adequate maturation of the nervous system, the development of behavioral, cognitive, and speech functions, and higher ocular coordination scores in infants and young children [14]. DHA, together with EPA, influences adequate surfactant synthesis, which, when deficient, can lead to acute respiratory failure in preterm infants [13]. DHA also affects increasing the absorption of calcium in the fetus, resulting in normal mineralization of bone tissue. This acid reduces the risk of metabolic syndrome and promotes immunity [15].

Ensuring an optimal supply and availability of DHA in the mother-to-be's diet has a great impact on prolonging the duration of pregnancy, which is protective against the occurrence of preterm birth, and on increasing the birth weight of the newborn, without increasing the risk of macrosomia [12,14,16]. A study in which 800 mg of DHA per day was given to pregnant women showed a significant increase in the duration of pregnancy and the birth weight of the baby [17], while the same effect was already achieved with lower doses of this acid [18]. Research suggests a link between DHA and EPA supplementation and a reduction in the risk of postnatal depression in women [19]. In contrast, another study shows a decrease in the rate of depression from the second trimester to delivery only in women who already had symptoms of this condition [20]. Most of the studies conducted do not show a significant effect on mean depression scores and the occurrence of major depressive symptoms during pregnancy and in the early postnatal period [21,22,23]. Given the lack of conclusive data regarding the effect of DHA and EPA on the risk of perinatal depression, further research is needed.

Fatty acids from fish reduce the risk of asthma and may also be beneficial in the prevention of other allergic diseases [23,24]. In a study conducted by researchers in Finland, analysis of the data obtained showed that a higher intake of fish products and fish alone was associated with a reduced risk of developing asthma [25]. Consumption of such products by women during pregnancy may be a strategy for preventing the onset of asthma, atopic dermatitis, allergic rhinitis, and food allergies in infants and children later in life [26].

Low plasma concentrations of EPA, like DHA, during the first and second trimester of pregnancy, are associated with an increased risk of preterm birth [18,27]. In the analysis conducted, pregnant women were divided into four quintiles according to their level of EPA + DHA intake. Women in the group with the lowest EPA + DHA intake were at a 48-fold increased risk of preterm birth, compared to groups of women with a higher EPA + DHA intake [28].

As essential components for the human brain, omega-3 fatty acids, including EPA and DHA, are closely linked to cognitive function and academic performance. Decreased blood concentrations of n-3 PFAs are observed in children and adolescents with ADHD. Treatment with omega-3 fatty acids improves clinical symptoms in adolescents with ADHD, particularly due to higher levels of EPA compared to DHA [29,30,31,32]. Adolescents with the lowest baseline levels of endogenous EPA show the greatest improvement in cognitive function after EPA treatment because high levels of inflammation result in a stronger response to anti-inflammatory intervention [29]. Despite the tremendous effect of EPA on improving attention and impulsivity in children with ADHD, a combined EPA + DHA intervention may have a broader impact on the clinical symptoms of ADHD and minimize inflammation [29,30]. Dietary supplementation with n-3 s is useful as an adjunct to standard pharmacological therapies in ADHD. Despite the low likelihood of achieving the same therapeutic effects as with stimulant medication in ADHD, supplementation with n-3 resulted in maintenance of behavioral improvement, even when switching medications [30,33].

The aim of the study was to assess the frequency of consumption of fish, vegetable oils, and products rich in polyunsaturated fatty acids and evaluate DHA supplementation by pregnant women, as well as to assess knowledge of PFAs, especially DHA and EPA.

2. MATERIAL AND METHOD

2.1. Conduct of the study

The study was conducted using a questionnaire method, with a direct survey technique using a computer-assisted personal interview (CAPI- Computer Assisted Personal Interview**)** from September 2019 to February 2020 among pregnant women attending randomly selected birthing schools in the Silesian Voivodeship in Poland. A cluster sampling method was used to select the sample, guided by the specialty of the medical facility within the birthing schools. The study selected 5 birthing schools in which interviews were collected. The sampling method was based on the ethical principles of conducting scientific research with the participation of people - by the Declaration of Helsinki.

2.2. Characteristics of the study group

A total of 247 pregnant women were studied. After applying the inclusion and exclusion criterion, 210 pregnant women aged between 18 and 40 years, in their third trimester of pregnancy attending the Childbirth School were qualified for the study proper. 114 respondents (54.75%) were pregnant women aged 26-30 years, while 4 respondents (1.30%) were between 18-20 years and 7 of the respondents (4.48%) were between 36-40 years. 144 female respondents (68.57%) lived in an urban area, while 66 respondents (31.43%) lived in a rural area. Most of the female respondents had a university education 130 women (61.72%). Body mass index BMI was also assessed based on height and weight in the study group of women before pregnancy. 67.14% of the subjects were of normal weight, 14.29% were overweight, 8.57% were obese, and 10.0% were underweight.

2.3.Inclusion criteria

Pregnant women participating in the study gave informed consent to participate in the study, and a questionnaire interview was only conducted when consent to participate in this study was obtained. Eligibility criteria for the study were written consent to participate in the study, age above 18 years, female sex, being in the third trimester of pregnancy at the time of the study. The main exclusion criterion from the study was the first or second trimester of pregnancy. Further exclusion criteria were lack of consent to participate in the study, age below 18 years, or male sex.

2.4. Research tool

A survey questionnaire was used as the research tool, including both closed questions: single or multiple choice, and open-ended questions. The questionnaire consisted of a questionnaire with a header, questions to check the respondents' knowledge of selected fatty acids - the best sources, their needs, and effects of their consumption on a pregnant woman and the developing fetus, as well as a section on the consumption of products rich in both animal and vegetable fats. Respondents were also asked about the most commonly used techniques for cooking fish and DHA supplementation during pregnancy.

2.5. Statistical analysis

The database and the processing of the results were done using Microsoft Excel. Statsoft Statistica 13.0 was used for statistical analyses.

3. RESULTS

In the surveyed group of pregnant women, the most frequently indicated fat-rich product was butter, whose frequent consumption was declared by 129 of all the women surveyed (61.43%). Olive oil, as one of the main sources of fat, is consumed by 111 pregnant women surveyed (52.86%), while in 98 respondents (46.67%) one of the most frequently consumed fat products is nuts. 2 of the women surveyed (0.95%) reach for hard margarine in their daily diet, and another 3 respondents (1.43%) declared frequent consumption of animal fats such as lard and tallow.

Table.1 Frequency of consumption of marine fish and nuts, seeds, and stones by female respondents N=210

Product	**Frequency of consumption of marine fish and nuts. seeds and stones by pregnant women (N=210)**											
	Daily		**4-6 times a week**		**2-3 times a week**		**Once a week**		**Less than once a week**		**It shall not consume**	
	n	%	n	%	n	%	n	%	n	%	n	%
Marine fish	2	0.95	5	2.38	**27**	**12.86**	63	30	80	38.10	**33**	**15.71**
Walnuts	9	4.29	**21**	**10.00**	**42**	**20.00**	33	15.71	60	28.57	45	21.43
Hazelnuts	7	3.33	9	4.29	14	6.67	18	8.57	79	37.62	83	39.52
Cashew nuts	3	1.43	7	3.33	16	7.62	28	13.33	71	33.81	85	40.48
Almonds	13	6.19	16	7.62	22	10.48	28	13.33	66	31.43	65	30.95
Linseed	10	4.76	10	4.76	20	9.52	9	4.29	37	17.62	**124**	**59.05**
Pumpkin seeds	2	0.95	7	3.33	15	7.14	25	11.90	58	27.62	103	49.05
Sunflower	6	2.86	14	6.67	28	13.33	35	16.67	73	34.76	54	25.71
Sesame	2	0.95	4	1.90	9	4.29	13	6.19	48	22.86	134	63.81

The pregnant women surveyed were asked about the frequency of consumption of selected products rich in fatty acids. The analysis showed that 27 respondents (12.86%) consumed fish frequently enough - 2-3 times per week. 63 respondents (30%) consumed seafood once a week, while 80 pregnant women surveyed (38.1%) consumed it less frequently than once a week and 33 of them (15.71%) did not consume it at all.

With regard to the consumption of different types of nuts and seeds, the most popular nuts were walnuts, the most abundant in PFAs, consumed 4-6 times a week by 21 women (10%), 2-3 times a week by 42 (20%) and once a week by 33 (15.71%). Regarding products that are a good source of ALA: flaxseed was used in the daily diet by 10 respondents (4.76%), while 124 female respondents (59.05%) did not consume it at all.

In the daily diet of the pregnant women surveyed, olive oil was the most commonly used fat, with 30 respondents (14.29%) declaring that they consumed it every day. Canola oil was consumed 4-6 times a week by 59 women (28.1%). Consumption of ALA-rich linseed oil 2-3 times a week was declared by 13 female respondents (6.19%), 15 of them (7.14%) consumed it once a week and 152 respondents (72.38%) declared that they did not consume it at all. The least popular fats among the pregnant women surveyed included: grape seed oil, soybean oil, corn oil and evening primrose oil (Tab.1.).

Tab 2. Frequency of consumption of vegetable oils by female respondents N=210

Product	**Frequency of vegetable oil consumption by pregnant women (N=210)**											
	Daily		**4-6 times a week**		**2-3 times a week**		**Once a week**		**Less than once a week**		**It shall not consume**	
	n	%	n	%	n	%	n	%	n	%	n	%
Linseed oil	2	0.95	1	0.48	13	6.19	15	7.14	27	12.86	**152**	**72.38**
Olive oil	**30**	**14.29**	51	24.29	46	21.90	26	12.38	26	12.38	31	14.76
Canola oil	14	6.67	59	28.10	45	21.43	32	15.24	21	10.00	39	18.57
Grape seed oil	0	0.00	2	0.95	3	1.43	11	5.24	15	7.14	179	85.24
Soybean oil	0	0.00	0	0.00	0	0.00	3	1.43	6	2.86	201	95.71
Sunflower oil	0	0.00	22	10.48	24	11.43	20	9.52	25	11.90	119	56.67
Maize oil	0	0.00	1	0.48	0	0.00	1	0.48	7	3.33	201	95.71
Evening primrose oil	4	1.90	1	0.48	1	0.48	3	1.43	5	2.38	196	93.33

The analysis of the open question on the most frequently consumed fish species showed that 103 pregnant women surveyed (49.05%) most frequently consumed salmon, the most abundant in DHA. 73 respondents (34.76%) declared frequent consumption of cod, and 42 respondents (20%) reached for trout. 43 of the pregnant women surveyed (20.48%) also chose other fish species, among which tuna, panga, carp and halibut were among the most frequently mentioned (Tab.3.).

Tab 3. Most commonly consumed fish species among female respondents N=210

Species of fish	Consumption by pregnant women surveyed (N=210)	
	n	%
Salmon	103	49.05%
Cod	73	34.76%
Trout	42	20.00%
Zander	2	0.95%
Mackerel	31	14.76%
Pollock	14	6.67%
Miruna	14	6.67%
Herring	16	7.62%
Other	43	20.48%

The survey also looked at the type of heat treatment most commonly used to prepare fish, with 101 pregnant women surveyed (48.1%) indicating baking. Pan-frying was also a frequently used type of fish preparation among respondents, as declared by 54 surveyed women (25.71%), grilling, used by 48 respondents (22.86%), and steaming, used by 42 respondents (20%) (Tab. 4.).

Tab.4 Most common types of heat treatment used by female respondents to prepare fish N=210

Type of heat treatment	Most frequently used methods of fish preparation by female respondents (N=210)	
	n	%
Baking	101	48.10%
Sauteed frying	28	13.33%
Battered frying	54	25.71%
Cooking in water	4	1.90%
Steaming	42	20.00%
Grilling	48	22.86%

Among all the pregnant women surveyed, 122 respondents (58.1%) declared to use mainly rapeseed oil for frying food. 55 respondents (26.19%) used olive oil for frying, and only a small proportion of the study group used saturated fats for this purpose, such as: lard - 5 respondents (2.38%), coconut oil - 13 respondents (6.19%) or margarine, used by 4 study women (1.9%) (Tab.5).

Tab. 5. most commonly used types of frying fat among female respondents (N=210)

Type of fat	Types of fat used for frying by female respondents (N=210)	
	n	%
Butter	37	17.62%
Canola oil	122	58.10%
Olive oil	55	26.19%
Margarine	4	1.90%
Coconut oil	13	6.19%
Sunflower oil	31	14.76%
Lard	5	2.38%

Considering the supplementation of DHA during pregnancy, as well as the amounts of supplemental DHA in mg, if supplementation was used, 113 female respondents (53.81%) declared that they did not know if they were supplementing the aforementioned acid. 58 respondents (27.62%) took DHA daily during pregnancy and 19 of them (9.05%) took a DHA supplement of 300 mg/day. 39 women surveyed (18.57%) explicitly stated that they do not use DHA supplementation during pregnancy.

4. DISCUSSION

Over the 1990s, there was a reconfiguration of the accepted pattern of fat consumption in Poland. The demand for vegetable fats was growing intensively, while the demand for animal fats, especially butter, was decreasing. Between 1991 and 1997, the consumption of vegetable fats increased with the highest dynamics, compared to other vegetable and animal products. There was an increase in consumption of 12% per year, which per capita was 7.6 kg in 1990 to 16.9 kg in 1997. Animal fats lost their dominant place in total fat consumption to fats of plant origin, whose share of total fat consumption increased from about 30% to more than 50% and 60% [34]. Over the period 1998 to 2003, the increase in vegetable fat consumption slowed considerably, while the decline in animal fat consumption was halted. In 2003, consumption of vegetable fats increased to 17.6 kg per capita and total fat consumption was 29.2 kg per capita. In 2004, due to a large increase in food prices, especially for animal fats, consumption of vegetable oils continued its upward trend and amounted to 19.7 kg per capita - 11.9% more than in the previous year [35]. During the following 11 years, vegetable fat consumption increased at a slower rate, averaging less than 2% per year, and more than compensated for declines in animal fat consumption (excluding 2005, 2006, and 2013), which averaged more than 1% per year. In 2015, total fat consumption was 33.5 kg per capita and the share of vegetable fats about total consumption increased again to 23.4 kg per capita. The national demand for fats in 2015 was 70% covered by fats of vegetable origin [34].In turn, the results of the WOBASZ program from 2005, examining the consumption of food products among the adult population of Poland, indicate that the average consumption of added fats, both of animal and vegetable origin, was 59 g/day among men, which represented 107% of the recommended daily value in the food ration.

In contrast, among women, the consumption of added fats reached 41g/day or 103% of the recommended value. In the diet of the Polish population, vegetable fats accounted for 47% and 44% of added fat in men and women, respectively [35].

A 2011 study of 182 healthy adult men and women indicates that total fat coverage was 36% per day, of which polyunsaturated fatty acids accounted for 5.7%, including omega- 3: 0.9% and omega-6: 4.8%. The average consumption of polyunsaturated fatty acids among the subjects was 11g/day, n-3 over 1.7g/day, and n-6 about 9g/day, indicating an n-6/n-3 ratio of 5.16 [36].

Meeting the demand for essential fatty acids, including PFAs, is at the heart of a healthy diet, which is necessary to maintain full health and reduce the risk of numerous chronic diseases. Due to their health-promoting properties resulting from their high content of omega-3 fatty acids, especially DHA and EPA, marine fish are among the products that should be regularly included in everyone's diet. The increased need for these acids during pregnancy, due to their numerous protective properties for both the woman and the fetus, makes them particularly important in the diet of the mother-to-be. According to the standards developed by the National Centre for Nutrition Education [4], it is recommended to consume at least 2 portions of fish per week, which corresponds to covering the requirement for DHA and EPA of 250 mg/day. Our research shows that pregnant women do not consume the recommended amount of fish per week. Consumption of fish in the recommended amount - 2-3 times per week was recorded only in 12.86% of the surveyed pregnant women. A small percentage of respondents declared more frequent consumption of marine fish. Everyday fish is consumed by 0.95% of respondents, while 4-6 times a week by 2.38%. The largest proportion of respondents consume fish less frequently than once a week, 30% of respondents consume fish once a week and 15.71% do not consume fish at all.

The results of other studies also report that fish consumption by pregnant women is not in line with recommendations. In one study conducted in Warsaw among 204 pregnant women, only 23% of the respondents declared that they consumed fish 2 to 3 times a week, while the vast majority consumed fish once a week or once every fortnight [37]. Wierzejska et al [38] also found that marine fish are consumed too infrequently by pregnant women, of whom only 10% followed the recommendations, consuming fish 2 times a week. The greater part reached for it once a week, and the largest group of women surveyed even less frequently - 1-3 times a month. In the Gacek survey of pregnant women, more than half (60.8%) of the respondents consumed fish once a week, and only a negligible proportion of women aged 31-47 consumed fish 2-3 times a week. None of the younger women consumed fish as recommended [39].

An analysis of the dietary behavior of pregnant women by Misan et al. brings further evidence of the under-consumption of fish by expectant mothers. Only 17.6% of the women surveyed consumed the recommended amount of fish, while the vast majority reached for fish only once a week [40]. Similar results were reported in the study by Kobus-Cisowska et al [41], where out of 100 pregnant women surveyed, 68% consumed fish only once a week and as many as 30% consumed fish 1-2 times a month. An analysis of the diets of 111 pregnant women from Łódź also found that only 32.43% of the respondents consumed fish several times a week [42], while the work of Wesołowska et al [43], whose study involved 1306 pregnant women, found that less than 35% of respondents consumed fish at least once a week.

A slightly different percentage distribution can be seen in a study by Pieczyńska et al. relating to the effect of pregnancy progression on the structure of dietary fatty acid consumption, where the researchers noted an increase in fish consumption as the pregnancy progressed. In this analysis, more than half of the pregnant women studied, 57% and 55%, in the second and third trimesters of pregnancy respectively, consumed the recommended 2-3 portions of marine fish per week [44]. In the analysis of nutrition of pregnant hospital patients from the area of the Warmińsko-Mazurskie Voivodeship, the consumption of fish and seafood was almost twice as high as in women participating in the nationwide WOBASZ study. However, none of the expectant mothers had sufficient intake to provide at least 200 mg of DHA per day [45]. Nordgren et al. in their study found that the DHA intake of pregnant women was only 66 g/day and did not differ significantly compared to women of childbearing age who were not expecting a child. Such data may also indicate an under-consumption of fish in the study group [46]. Similarly, the work of Gaitan et al. reported a DHA intake of approximately 72 g/day of DHA [47]. Results adequate to the previous ones were obtained in a study of Brazilian pregnant women [48], who consumed an average of 66 mg of DHA and EPA in the first trimester of pregnancy and 85 mg in the third trimester.

Fish consumption is too low in the general population of Poland. According to the Small Statistical Yearbook of Poland for 2017 [49], fish consumption per day and per capita was 11g. According to the recommendation for the consumption of 2 portions of fish per week, the daily intake should be 30g calculated that one portion of fish equals 100g, which indicates more than half lower than the recommended daily intake. Very similar results were obtained in the WOBASZ study [50] conducted in 2005, where both women and men consumed only half the recommended amount of fish.

An analysis of the fish species most frequently consumed by pregnant women conducted by Wierzejska et al [38] showed that salmon and herring were the most common choices, while cod and pollock were the most popular among the much less frequently consumed lean fish species. A study by Broś-Konopielko also found that salmon was the most frequently eaten fish species among pregnant women surveyed [37]. The analysis of own work also showed that the respondents, when reaching for fish, most often chose salmon, which was declared by almost half of the respondents (49.05%). On the other hand, the second most frequently chosen species was cod.

Meeting the need for adequate amounts of DHA is extremely important during pregnancy. Sufficient accumulation of this acid in the brain and retina influences the normal development of the nervous system,and behavioural functions, enhances fetal immunity, as well as protects against the occurrence of preterm birth and increases the birth weight of the newborn [13, 14, 15, 16, 51] Given the great importance of DHA and EPA during pregnancy, according to the National Centre for Nutrition Education[4], pregnant women should take 250 mg/day of DHA + EPA, as recommended for adults + an additional 100-200 mg/day of DHA to ensure adequate concentration of these acids in the mother's body and optimal distribution to the foetus. According to the position of the Polish Group of Experts [6], pregnant women should supplement DHA in the amount of at least 200 mg per day, and in the case of low fish consumption, provide a supplementation dose of 400-600 mg DHA/day.

The recommendations of the Expert Team of the Polish Gynaecological Society [1,2] also recommend taking DHA supplements in case of low fish consumption and other sources of DHA in the amount of 500 mg/day starting from the first month of pregnancy. The analysis of the results of our work shows that just over half of the pregnant women surveyed do not know whether they are supplementing DHA during pregnancy. 18.57% of the respondents do not take supplements of this acid and only 27.62% of the surveyed women supplement DHA between 50 - 1000 mg/day. The highest percentage of respondents (9.09%) who use the aforementioned supplement take it at 300 mg/day (9.05%). Returning to the question on fish consumption, such a low percentage of women consuming marine fish as recommended should be related to the much larger group of women using the DHA supplement. The absence of such a relationship indicates an under-supply of DHA per day by the pregnant women surveyed.

In a study by Wierzejska et al [38], in which only 8% of pregnant women provided equal or more than 200 mg of DHA per day from food, it was noted that only 28% of the subjects declared supplementation with DHA preparations. In this group, the median total DHA intake per day was 201 mg. In a study by Thompson et al [52], which examined omega- 3 fatty acid intake according to age, sex and physiological status, no significant differences were found in the intake of DHA, EPA or DHA + EPA in pregnant women compared to non- pregnant women of childbearing age. An identical result was obtained in their study by Nordgren et al [46]. In another analysis of omega-3 fatty acid intake among pregnant women, as in the previously mentioned studies, an under-supply of these fatty acids was reported. Approximately 95% of the study population of women did not meet the recommended intake of 250 mg EPA and DHA per day, where the intake of these acids from food was approximately 79 g/day, and when combining food sources with dietary supplements, such a supply was ± 97.7 mg per day [53]. In an analysis by Harton et al [54], which found intakes of both DHA and EPA below the recommended amounts, it was noted that only one in three respondents used a supplement with DHA, and this trend was more often observed in women with higher education. In a study evaluating the use of different dietary supplements by women who were either pregnant or planning a pregnancy [55], it was observed that almost 33% of the study group declared supplementation with omega-3 PUSF, and this was twice as high as in the general population. Different results were obtained in their study by Pieczyńska et al [44], in which pregnant women studied covered the standard for DHA and EPA with supplementation and diet in 113.33%, which was probably related to quite frequent fish consumption, especially in the second and third trimester of pregnancy.

An adequate supply of fat, and of the individual fatty acid groups in the daily diet, plays an anplayrtant role in the normal course of pregnancy, the development of the foetus, and in maintaining the good health of the pregnant woman and her offspring. The results obtained in our study show an insufficient intake of products most rich in polyunsaturated fatty acids. One of the main sources of fat in the diet of more than half of the pregnant women surveyed (61.43%) was butter, in which saturated fatty acids predominate, while about products that are a rich source of PUSF and PFAs, only a minority of the subjects declared their daily intake. Such a relationship may indicate that the supply of saturated fatty acids is too high in relation to PUSF and VFAs among pregnant women.

In the study by Myszkowska - Ryciak et al [56], an excessive intake of PUSF, exceeding 10% of energy, was reported in relation to the standards, as well as a recommendation for the lowest possible intake of fatty acids from this group. The high level of fulfilment of the standard, accounting for 14% of energy from FFAs in the aforementioned study, is probably due to the frequent consumption of butter by pregnant women. The study by Sadowska and Krzeminska [57] and Pieczyńska et al [44] similarly to the earlier analysis showed an excessively high intake of FFAs, exceeding the recommendations. The results of an analysis among 100 pregnant women showed that as many as 35% of the subjects consumed butter and cream in three meals per day, while 60% consumed butter and cream in 1-2 meals per day [80]. Similar results were obtained in a study in which the vast majority (78.9%) were women of childbearing age - up to 40 years, where as many as 66.3% of respondents reported using butter as the most common type of fat for food preparation [58].

The products with the highest percentage of ALA were not consumed at all by the vast majority of pregnant women surveyed. Consumption of flaxseed oil 2-3 times a week was declared by only 6.19% of the respondents, and only 7.14% reach for it once a week. More frequent consumption occurs in only 3 of all surveyed women, while as many as 72.38% of respondents do not consume it at all. The pregnant women surveyed are slightly more likely to reach for the seeds from which linseed oil is produced than for linseed oil. Daily consumption of linseed was declared by 4.76% of the respondents, with the same number consuming it 4-6 times a week. However, still a large,st proportion of female respondents (59.05%) do not consume it at all. Among products rich in omega-3 fatty acids, nuts, mainly walnuts, were the most frequent choice. In contrast, the oils that appeared with the greatest frequency in the diets of the pregnant women surveyed - rapeseed oil and olive oil - are primary sources of monounsaturated fatty acids, despite some amounts of PFAs. About the intake of fats rich in fatty acids of the omega-6 family, sunflower oil was the most frequently chosen product by pregnant women. Despite the lack of detailed data regarding the intake of PFAs by the respondents, after analyzing the frequency of consumption of products rich in these acids, including the consumption of marine fish, it can be suspected that the consumption of PFAs by pregnant women is too low. The study by Sadowska and Krzeminska [57] reported an insufficient intake of PFAs, which was due, among other things, to the infrequent consumption of oily fish and oils by the women studied. The study by Pieczyńska et al [44], which analyzed the structure of fatty acid intake by the level of pregnancy, found that the recommendations regarding the proportion of energy from PFAs, whose proportion in the diet should oscillate between 6-10% of the energy supplied to the body, were followed to the least extent and by the lowest percentage of the women surveyed [4]. Only 10 percent of the respondents followed this recommendation, while in the rest of the respondents, energy from PFAs was only covered on average by less than 50 percent of the standard. This study also showed that the proportion of LA in the diet of pregnant women was around 3% of dietary energy, compared to 4% of the recommended amount. In contrast, the average intake of ALA in the study group covered no RMA in 105%, while the proportion of respondents meeting it doubled between the first and third trimesters of pregnancy. In a study of Norwegian pregnant women, the intake of PFAs was reported to be slightly below the lower limit of normal, as the median percentage energy coverage of these acids was 5.7%, while the interquartile range was from 5-6.8% [59].

A higher dietary supply of PFAs was reported in a study by Harton et al [54], in which the proportion of these fatty acids in the total daily ration was within the reference limits, at 6% of dietary energy. Also about ALA and LA, it was shown that the mean amounts of these acids in the daily rations of the women studied were within the recommendations. A similar result was obtained by Myszkowska-Ryciak et al [56], whose study reported an increased intake of PFAs between the second and third trimesters of pregnancy.

5. CONCLUSIONS

The dietary behavior of pregnant women related to fish consumption is not correct, the overall proportion of fish in the diet of the study subjects does not cover the recommended amounts. Vegetable oils and products rich in polyunsaturated fatty acids are not consumed with sufficient frequency by the pregnant women studied. DHA supplementation in the study group of pregnant women, despite low fish consumption, is underestimated and at a very low level.

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REFERENCES

1. Zimmer M, Sieroszewski P, Oszukowski P i wsp. Rekomendacje Polskiego Towarzystwa Ginekologów i Położników dotyczące suplementacji u kobiet ciężarnych. Ginekologia i Perinatologia Praktyczna 2020, T 5(4): 170–181.
2. Poręba R, Drews K, Karowicz-Bilińska A. Stanowisko Zespołu Ekspertów Polskiego Towarzystwa Ginekologicznego w zakresie suplementacji witamin i mikroelementów podczas ciąży. Ginekol Pol. 2011, 82: 550-553
3. Pudło H, Respondek M. Programowanie żywieniowe - wpływ odżywiania kobiet w ciąży na zdrowie dziecka = Nutritional programming - the impact of nutrition of pregnant women on the health of their children. Journal of Education, Health and Sport 2016; 6 (7):589-600
4. Jarosz M i wsp.. Normy żywienia dla populacji Polski i ich zastosowanie. Narodowy Instytut Zdrowia Publicznego – Państwowy Zakład Higieny, 2020.
5. Wendołowicz A, Stefańska E, Ostrowska L. Żywienie kobiet w okresie ciąży. Medycyna Ogólna i Nauki o Zdrowiu 2014; t. 20, Nr 3, 341–345
6. Czajkowski K, Czerwionka-Szaflarska M, Charzewska J i wsp. Stanowisko Grupy Ekspertów w sprawie suplementacji kwasu dokozaheksaenowego i innych kwasów tłuszczowych omega- 3 w populacji kobiet ciężarnych, karmiących piersią oraz niemowląt i dzieci do lat 3. Pediatria Polska 2010; 597-603
7. Bednarek W, Karowicz-Bilińska A, Kotarski J, Nowak-Markwitz E, Poręba R, Spaczyński M. Rekomendacje Zespołu Ekspertów Polskiego Towarzystwa Ginekologicznego w zakresie stosowania kwasów omega-3 w położnictwie. Ginekologia Polska 2010; 81, 467-469

8. Łoźna K, Kita A, Styczyńska M, Biernat J. Skład kwasów tłuszczowych olejów zalecanych w profilaktyce chorób cywilizacyjnych. Probl Hig Epidemiol 2012; 93(4): 871-875
9. Alexander DD, Miller PE, Van Elswyk ME, Kuratko CN, Bylsma LC. A meta-analysis of randomized controlled trials and prospective cohort studies of eicosapentaenoic and docosahexaenoic long-chain omega-3 fatty acids and coronary heart disease risk. Mayo Clin. Proc 2017; 92: 15–29
10. Materac E, Marczyński Z, Bodek KH. Rola kwasów tłuszczowych omega-3 i omega-6 w organizmie człowieka. Bromatologia i Chemia Toksykologiczna – XLVI 2013; 2: 225 – 233
11. Kolanowski W. Funkcje i przemiany metaboliczne wielonienasyconych kwasów tłuszczowych omega-3 w organizmie człowieka. Bromatologia i Chemia Toksykologiczna – XLVI 2013; 3: 267 – 278
12. Kunachowicz H. Wartość odżywcza wybranych produktów spożywczych i typowych potraw, 2017.
13. Wendołowicz A, Stefańska E, Ostrowska L. Żywienie kobiet w okresie ciąży. Medycyna Ogólna i Nauki o Zdrowiu 2014; 20 (3): 341–345
14. Swanson D, Block R, Mousa SA. Omega-3 Fatty Acids EPA and DHA: Health Benefits Throughout Life. Advances in Nutrition 2012; 3: 1–7
15. Kazimierska I. DHA – kwas dla matki i dziecka. Puls Medycyny, 2012
16. Karowicz-Bilińska A, Nowak-Markwitz E, Opala T, Oszukowski P, Poręba R, Spaczyński M. Rekomendacje Polskiego Towarzystwa Ginekologicznego w zakresie stosowania witamin i mikroelementów u kobiet planujących ciążę, ciężarnych i karmiących. Ginekologia Polska 2014; 85: 395-399
17. Makrides M, Gibson RA, McPhee AJ, Yelland L, Quinlivan J, Ryan P. DOMInO Investigative Team. Effect of DHA supplementation during pregnancy on maternal depression and neurodevelopment of young children. JAMA 2010; 304: 1675–83
18. Carlson SE, Colombo J, Gajewski BJ et al. DHA supplementation and pregnancy outcomes. Am J Clin Nutr 2013; 97(4): 808–815
19. Markhus MW, Skotheim S, Graff IE et al. Low Omega-3 Index in Pregnancy Is a Possible Biological Risk Factor for Postpartum Depression. PLoS One 2013; 8(7): e67617
20. Santoz Vaz J, Farias DR, Adegboye ARA, Nardi AE, Kac G. Omega-3 supplementation from pregnancy to postpartum to prevent depressive symptoms: a randomized placebo-controlled trial. BMC Pregnancy Childbirth 2017; 17: 180
21. Mozurkewich EL, Clinton CM, Chilimigras JL et al. The Mothers, Omega-3, and Mental Health Study: a double-blind, randomized controlled trial. Am J Obstet Gynecol 2013; Apr: 208(4): 313
22. Sallis H, Steer C, Paternoster L, Smith GD, Evans J. Perinatal depression and omega-3 fatty acids: A Mendelian randomisation study. J Affect Disord 2014; Sep: 166(100): 124–131
23. Zbrojewicz Z, Adamek M, Machelski A, Wójcik W. Wpływ kwasów tłuszczowych (omega) zawartych w rybach na organizm człowieka. Med Rodz 2015; 3(18): 137-143
24. Miyata J, Arita M. Role of omega-3 fatty acids and their metabolites in asthma and allergic diseases. Allergology International 2015; 64 (1): 27-34
25. Lumia M, Takkinen HM, Luukkainen P et al. Food consumption and risk of childhood asthma. Pediatr Allergy Immunol 2015; 26(8):789-796.
26. Miles EA, Calder PC. Can Early Omega-3 Fatty Acid Exposure Reduce Risk of Childhood Allergic Disease? Nutrients. 2017 Jul; 9(7): 784.
27. Hauner H, Much D, Vollhardt C. Effect of reducing the n-6:n-3 long-chain PUFA ratio during pregnancy and lactation on infant adipose tissue growth within the first year of life: an open- label randomized controlled trial. Am J Clin Nutr 2012; 95(2): 383–394.

28. Olsen SF, Halldorsson TI, Thorne-Lyman AL et al. Plasma Concentrations of Long Chain N-3 Fatty Acids in Early and Mid-Pregnancy and Risk of Early Preterm Birth. EBioMedicine 2018; Sep: 35: 325–333. doi: 10.1016/j.ebiom.2018.07.009.
29. Chang J, Su KP, Mondelli V et al. High-dose eicosapentaenoic acid (EPA) improves attention and vigilance in children and adolescents with attention deficit hyperactivity disorder (ADHD) and low endogenous EPA levels. Transl Psychiatry 2019; 9: 303. doi: 10.1038/s41398-019- 0633-0.
30. Bos DJ, Oranje B, Veerhoek ES et al. Reduced Symptoms of Inattention after Dietary Omega-3 Fatty Acid Supplementation in Boys with and without Attention Deficit/Hyperactivity Disorder. Neuropsychopharmacology 2015; Sep: 40(10): 2298–2306. doi: 10.1038/npp.2015.73.
31. Bloch MH, Qawasmi A. Omega-3 fatty acid supplementation for the treatment of children with attention-deficit/hyperactivity disorder symptomatology: systematic review and meta- analysis. J Am Acad Child Adolesc Psychiatry 2011; 50: 991–1000.
32. Chang P, Su KP, Mondelli V, Pariante CM. Omega-3 Polyunsaturated Fatty Acids in Youths with Attention Deficit Hyperactivity Disorder: a Systematic Review and Meta-Analysis of Clinical Trials and Biological Studies. Neuropsychopharmacology 2018; Feb: 43(3): 534– 545. doi: 10.1038/npp.2017.160.
33. Agostoni C, Nobile M, Ciappolino V et al. The Role of Omega-3 Fatty Acids in Developmental Psychopathology: A Systematic Review on Early Psychosis, Autism, and ADHD. Int J Mol Sci. 2017 Dec; 18(12): 2608. doi: 10.3390/ijms18122608.
34. Rosiak E. Spożycie tłuszczów w Polsce i Unii Europejskiej. Zeszyty Naukowe Szkoły Głównej Gospodarstwa Wiejskiego w Warszawie. Problemy Rolnictwa Światowego; 2016: t. 16 (XXXI), zeszyt 2; 279–288
35. Sygnowska E, Waśkiewicz A, Głuszek J i wsp. Spożycie produktów spożywczych przez dorosłą populację Polski. Wyniki programu WOBASZ. Kardiologia Polska 2005; 63: 6
36. Jabłonowska B, Dłużniewska B, Jarosz A, Nowicka G. Ocena spożycia wielonienasyconych kwasów tłuszczowych n-3 wśród zdrowych dorosłych osób w odniesieniu do aktualnych norm żywienia. Roczn. PZH 2011; 62 (4): 389 – 396
37. Broś-Konopielko M, Białek A, Oleszczuk-Modzelewska L. Consumption of fish and seafood by pregnant Polish women and the supply of docosahexaenoic acid and eicosapentaenoic acid from these products. Family Medicine & Primary Care Review 2017; 19 (3):191–195 doi: https://doi. org/10.5114/fmpcr.2017.69272
38. Wierzejska R, Jarosz M, Wojda B, Siuba-Strzelińska M. Dietetaty intake of DHA during pregnancy: a significant gap between the actual intake and current nutritional recommendations. Rocz Panstw Zakl Hig 2018; 69(4):381-386. https://doi.org/10.32394/rpzh.2018.0044
39. Gacek M. Niektóre zachowania zdrowotne oraz wybrane wskaźniki stanu zdrowia grupy kobiet ciężarnych. Probl Hig Epidemiol 2010; 91(1): 48-53
40. Misan N, Paczkowska K, Szmyt M. Nutritional behavior in pregnancy. Ginekologia Polska 2019; 90 (9): 527-533
41. Kobus-Cisowska J, Kmiecik D, Przeor M, Jędrusek-Golińska A, Waszkowiak K, Żołna H. Ocena poziomu wiedzy żywieniowej i sposobu żywienia kobiet w okresie ciąży. Bromat. Chem. Toksykol. – XLIX 2016; 3: 531 – 535
42. Godala M, Pietrzak K, Łaszek M, Gawron-Skarbek A, Szatko F. Zachowania zdrowotne łódzkich kobiet w ciąży. Cz. I. Sposób żywienia i suplementacja witaminowo-mineralna. Probl Hig Epidemiol 2012; 93(1): 38-42
43. Wesołowska E, Jankowska A, Trafalska i wsp. Sociodemographic, Lifestyle, Environmental and Pregnancy-Related Determinants of Dietary Patterns during Pregnancy. Int J Environ Res Public Health 2019; Mar, 16(5): 754. doi: 10.3390/ijerph16050754

44. Pieczyńska J, Sozański R, Kłósek A, Grajeta H. Wpływ zaawansowania ciąży na strukturę spożycia kwasów tłuszczowych z dietą przez kobiety ciężarne. Probl Hig Epidemiol 2017; 98(1): 73-80
45. Przybyłowska K, Kalinowska K. Żywienie kobiet w ciąży a stan urodzeniowy noworodków wyrażony indeksem Ponderala. Probl Hig Epidemiol 2011; 92(3): 508-511
46. Nordgren TM, Lyden E, Anderson-Berry A, Hanson C. Omega-3 fatty acid intake of pregnant women and women of childbearing age in the United States: Potential for deficiency? Nutrients 2017; 9 (3):197. doi:10.3390/nu9030197.
47. Gaitán AV, Drewery ML, Thaxton CA et all. Dietary intake and omega-3 DHA status in pregnant women who are overweight. J Obstet Gynecol Neonatal Nurs 2017; May, 47(3):438-450. doi: 10.1016/j.jogn.2017.08.008.
48. Pinto TJP, Farias DR, Rebelo F et al. Lower inter-partuminterval and unhealthy life-style factors are inversely associated with n-3 essential fatty acids changes during pregnancy: a prospective cohort with Brazilian women. PLoS One 2015; 10(3): e0121151.
49. Mały rocznik statystyczny Polski 2017, Główny Urząd Statystyczny. Warszawa, rok LX
50. Sygnowska E, Waśkiewicz A, Głuszek J i wsp. Spożycie produktów spożywczych przez dorosłą populację Polski. Wyniki programu WOBASZ. Kardiologia Polska 2005; 63(6)
51. Czerwińska E. Czynniki wpływające na poród przedwczesny. Ginekologia i Perinatologia Praktyczna 2018; 3(2): 52–57
52. Thompson M, Hein N, Hanson C et al. Omega-3 Fatty Acid Intake by Age, Gender, and Pregnancy Status in the United States: National Health and Nutrition Examination Survey 2003–2014. Nutrients 2019; Jan, 11(1): 177. doi: 10.3390/nu11010177
53. Zhang Z, Fulgoni VL, Kris-Etherton PM, Hazels Mitmesser S. Dietary Intakes of EPA and DHA Omega-3 Fatty Acids among US Childbearing-Age and Pregnant Women: An Analysis of NHANES 2001–2014. Nutrients. 2018; Apr, 10(4): 416. doi: 10.3390/nu10040416
54. 9Harton A, Choroszewska A, Gajewska D, Myszkowska-Ryciak J. Spożycie wielonienasyconych kwasów tłuszczowych przez kobiety ciężarne. Probl Hig Epidemiol 2013; 94(3): 605-609
55. Grzelak T, Suliga K, Sperling M, Pelczyńska M, Czyżewska K. Ocena stosowania suplementów diety wśród kobiet ciężarnych lub planujących ciążę. Forum Zaburzeń Metabolicznych 2016; t. 7 (1): 8–15
56. Myszkowska-Ryciak J, Gurtatowska A, Harton A, Gajewska D. Poziom wiedzy żywieniowej a wybrane aspekty sposobu żywienia kobiet w okresie ciąży. Probl Hig Epidemiol 2013; 94(3): 600-604.
57. Sadowska J, Krzemińska J. Porównanie sposobu żywienia zdrowych kobiet w ciąży i obciążonych cukrzycą ciążową typu G1. Forum Zaburzeń Metabolicznych 2015; 6(4): 160– 169
58. Korzeniowska-Ginter R, Czarniecka-Skubina E. Wykorzystanie Tłuszczów do przygotowania potraw smażonych w warunkach domowych. Bromat. Chem. Toksykol. – XLV 2012; (3): 1117–1122
59. Saunders CM, Rehbinder EM, Lødrup Carlsen KC et al. Food and nutrient intake and adherence to dietary recommendations during pregnancy: a Nordic mother-child population- based cohort. Food Nutr Res 2019; Dec, 20;63. doi: 10.29219/fnr.v63.3676