



## Vegetarian diet observed by pregnant women. Benefits and risks for mother and fetus

### Dieta wegetariańska stosowana przez kobiety w ciąży. Korzyści i zagrożenia dla matki i płodu

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#### ABSTRACT

**INTRODUCTION:** Nutritionists emphasize that a properly composed vegetarian diet can be followed by people at different stages of their lives. Still, many people believe that such an action can lead to the appearance health disorders. Therefore, the aim of this study was to determine whether a vegetarian diet can be observed by pregnant women without the risk of health disorders in them or the fetuses.

**MATERIAL AND METHODS:** Information relating to the suitability of a vegetarian diet during pregnancy was analyzed. The results of several studies that compared the occurrence of certain factors in pregnant women following a vegetarian diet and pregnant women consuming meat was analyzed.

**RESULTS:** At present, there are still few studies assessing the health status of pregnant women subsisting on a vegetarian diet and their children. These studies compared the bioavailability of nutrients, minerals and vitamins. The dietary habits of pregnant women living on a vegetarian diet are analyzed and the state of health of children born to vegetarians and women consuming meat is compared.

**CONCLUSIONS:** The research results presented in the study lead to the conclusion that a properly designed vegetarian diet can be followed by pregnant women without bearing a risk of deficiencies or disorders in fetal development.

#### SŁOWA KLUCZOWE

pregnancy, comparison, infants, pregnant women, vegetarian diet, nutrition

Received: 12.09.2016

Revised: 25.05.2017

Accepted: 25.06.2017

Published online: 26.03.2018

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## STRESZCZENIE

**WSTĘP:** Dietetycy podkreślają, że właściwie skomponowana dieta wegetariańska może być stosowana przez ludzi na różnych etapach ich życia. Jednak wciąż wiele osób uważa, że takie działanie może prowadzić do ujawniania się zaburzeń zdrowotnych. Celem pracy było określenie, czy dieta wegetariańska może być stosowana przez kobiety w ciąży bez ryzyka wystąpienia zaburzeń zdrowotnych u nich lub u płodów.

**MATERIAŁ I METODY:** Analizie poddano informacje odnoszące się do możliwości stosowania diety wegetariańskiej w czasie ciąży. Analizowano wyniki kilkunastu badań, w których porównywano występowanie określonych czynników u kobiet w ciąży stosujących dietę wegetariańską oraz u kobiet w ciąży spożywających mięso.

**WYNIKI:** Obecnie wciąż niewiele jest badań oceniających stan zdrowia kobiet w ciąży stosujących dietę wegetariańską oraz ich dzieci. W badaniach tych porównywana jest biodostępność składników odżywczych, składników mineralnych oraz witamin. Analizowane są nawyki żywieniowe kobiet w ciąży stosujących dietę wegetariańską oraz porównywany jest stan zdrowia dzieci urodzonych przez wegetarianki oraz kobiety spożywające mięso.

**WNIOSKI:** Przetastawione w pracy wyniki badań pozwalają stwierdzić, że właściwie opracowana dieta wegetariańska może być stosowana przez kobiety w ciąży i niesie ze sobą ryzyka wystąpienia niedoborów czy zaburzeń w rozwoju płodu.

## SŁOWA KLUCZOWE

ciąża, niemowlęta, żywienie, kobiety w ciąży, porównanie, dieta wegetariańska

## INTRODUCTION

Nutrition during pregnancy is particularly important because it affects both the health of the woman and her child. Rational nutrition of women during pregnancy should provide the right amount of energy, but also contain nutrients such as proteins, fats, carbohydrates, minerals and vitamins in the correct amounts and proportions. A vegetarian diet observed especially during pregnancy and lactation still remains controversial as its opponents suggest that it may cause undesirable nutritional and health effects. It can cause nutritional and health effects. The shortage of protein, calcium, iron, vitamin D and B12 deficiency, as well as the harmful effects of substances used for crop production are the most common reasons attesting to the adverse effects of this diet [1].

In Poland there is still no representative data on the size of the population of vegetarians. However, the estimated information indicates that a vegetarian diet is currently observed by about 1% of the population, and this proportion – like in Western Europe – is still increasing [2]. According to a survey conducted in 2013 among adult Poles, 1.6% followed a lacto-vegetarian diet, another 1.6% vegan diet; women most frequently declare themselves vegetarians [3].

According to the American Dietetic Association (ADA), a properly composed vegetarian diet, including its more restrictive variant, a vegan diet is healthy, meets the nutritional needs, and its use may carry significant health benefits, mainly in the context of prevention and treatment of specified diseases. A pro-

perly planned vegetarian diet can be successfully followed by people at all stages of their life, including pregnancy, lactation, infancy, childhood and adolescence [4].

Analysis based on scientific evidence has shown that a vegetarian diet can successfully meet the demand for nutrients essential for people at all stages of their life, especially for proteins, fatty acids, iron, iodine, zinc, calcium and vitamins such as vitamin D or vitamin B12. In some cases, mainly due to the increased demand of the body of a person observing a vegetarian diet, it is necessary to take additional supplements or consume foods fortified with specified ingredients. This does not, however, require the resignation of a vegetarian diet [4].

Additionally, previously conducted studies have shown that a vegetarian diet is associated with a lower risk of death from coronary heart disease. The observance of this diet also helps to lower the levels of LDL cholesterol and lower blood pressure. Persons subsisting on a vegetarian diet have a lower incidence rate of high blood pressure and type 2 diabetes. Experts from the American Dietetic Association emphasize the importance of a vegetarian diet in the context of normalization of body weight, normalization of the body mass index and a lower overall incidence of cancer. Among the features of a vegetarian diet which help to reduce the risk of chronic diseases, there is a lower saturated fat intake, lower cholesterol intake, higher fruit consumption, higher consumption of vegetables, higher consumption of unprocessed grains, higher consumption of nuts and dried legumes and a higher intake of dietary fiber [4].



In the context of the health importance of a vegetarian diet, it cannot be ignored that the diversity of eating habits which occur among vegetarians and vegans makes it essential for each person following such a diet to verify that it meets the individual's nutritional needs. Besides assessment of the dietary habits of vegetarians, nutritional education relating primarily to the sources of particular nutrients, how to purchase and prepare meals in the way that meets the individual nutritional needs is also necessary [5]. It is assumed that a well-planned vegetarian diet, lacto-vegetarian and ovo-lacto vegetarian diet is suitable for people at all stages of life, including pregnancy and lactation. A properly planned vegetarian diet can meet the nutritional needs of infants, children and adolescents, fostering their proper development.

### AIM

Therefore, the objective of the study is to determine if a vegetarian diet can be successfully observed by pregnant women without the risk of health complications for women and fetuses.

For the analysis the following research questions were formulated:

1. What is the difference between pregnant vegetarians and pregnant women not following a vegetarian diet in terms of the demand for macronutrients and energy?
2. What is the availability of different macronutrients in the diet of pregnant vegetarians?
3. What are the dietary habits of pregnant vegetarians regarding the consumption of macronutrients?
4. Is the state of health of infants born by vegetarians different from the health of newborns born to women who do not observe a vegetarian diet?

### MATERIAL AND METHODS

To achieve the objective the methods of analysis and criticism of literature were used. On the basis of available information, the authors attempted to determine whether women subsisting on a vegetarian diet during pregnancy are exposed to higher health risks arising from potential nutritional disorders and nutritional deficiencies. To evaluate the research on a vegetarian diet in pregnancy, analysis of studies based on scientific evidence was used. Regular review of the electronic databases MEDLINE and EMBASE was completed in December 2016 and supplemented by a search of the World Wide Web of Clinical Trials database for clinical trials and a reference list of relevant studies and reviews of articles. The study used

a descriptive type of systematic review that included randomized or quasi randomized clinical trials that met the following inclusion criteria:

- the possibilities of following a vegetarian diet for women planning pregnancy and pregnant women,
- risks associated with the observance of a vegetarian diet for women planning pregnancy and pregnant women,
- demand for nutrients consumed by pregnant women living on a vegetarian diet, and by women who prefer a customary diet containing meat and meat products,
- dietary habits of pregnant vegetarians,
- bioavailability of macronutrients in the diet of pregnant vegetarians and women having a typical diet containing meat and meat products,
- the impact of a vegetarian diet on the health of newborns.

The final studies include:

- four scientific studies evaluating the fulfillment of energy needs of pregnant women subsisting on a vegetarian diet and pregnant women consuming meat,
- six scientific studies evaluating the availability of macronutrients in the diet of pregnant vegetarians and pregnant women consuming meat,
- ten scientific studies evaluating the intake of nutrients in the diet of pregnant vegetarians,
- four studies evaluating the health status of infants born to vegetarians and health status of infants born to women who eat meat.

### RESULTS

#### **Energy-dependent differences between pregnant vegetarians and pregnant women who do not follow vegetarian diet**

The demand for nutrients and energy in the case of women who observed a vegetarian diet during pregnancy, and women who had a typical diet containing meat and meat products is not significantly different. As emphasized by specialists, a vegetarian diet can be planned and implemented in a manner that meets the nutritional requirements of not only pregnant women, but also women who are breastfeeding [6].

A review of available literature allowed us to identify four primary studies whose aim was a comparative analysis of the macronutrient intake by pregnant women observing ovo-lacto vegetarian and lacto-vegetarian diets: Campbell-Brown (1985), Drake (1998), Ganpule (2006) and Reddy (1994) [7,8,9,10].

Analysis of the information contained in the aforementioned reports showed first of all that none of these studies focused on the demand for nutrients and



minerals or its implementation in a group of pregnant vegans [7,8,9,10].

An additional review of available literature also allowed us to conclude that the number of studies specifically concerning nutrient intake by pregnant women following a vegetarian diet and pregnant women having a typical diet containing meat and meat products, especially relating to the population not residing within the United States is limited. The information obtained allow the authors to conclude that the consumption of macronutrients in pregnant women observing a vegetarian diet is similar to the macronutrient intake of pregnant women not following this diet. However, a number of subtle differences may be noticed between the intake of macronutrients in the compared groups. As pointed out in the analyzed and compared research, pregnant women existing on a vegetarian diet consume a slightly less amount of protein than pregnant women not living on a vegetarian diet. At the same time, pregnant vegetarians consume a slightly greater amount of carbohydrates than pregnant non-vegetarians. In this context, it is not without significance that none of the differences in the amount of nutrient intake presented above reveals clinically significant differences between the achieved results. Additionally, in none of the studies analyzed was there any occurrence of protein deficiency in the diet of pregnant vegetarian women [7,8,9,10].

#### **Bioavailability of different macronutrients in diet of pregnant vegetarians**

The available scientific publications and research results relating to the bioavailability of various nutrients, minerals and vitamins in the diet of pregnant women following a vegetarian diet were analyzed. A review of available literature allowed the authors to identify six scientific studies verifying both the bioavailability of macronutrients in the diet of pregnant women living on a vegetarian diet and in the foods of pregnant women subsisting on a diet containing meat and meat products.

Of all the selected studies five were carried out in the United States and covered the population of Americans, and the last of these studies was also carried out in the United States but it applied to both the population of American women and women living outside the United States.

For further analysis and comparison, the following studies were selected: Campbell-Brown (1985), Cheng (2004), Ellis (1987), Koebnick (2001, 2004), Ward (1988) [7,11,12,13,14,15].

The aforementioned research papers compared the availability of particular macronutrients in the diet of pregnant vegetarians and pregnant women following a diet containing meat and meat products. The researchers did not find statistically significant differences

in the availability of the majority of the necessary macronutrients in the diet of vegetarians and non-vegetarians. Among the macronutrients analyzed, only in the case of vitamin B12 in the blood serum of vegetarians and non-vegetarians were statistically significant differences reported. The amount of vitamin B12 in the blood serum of pregnant women existing on a vegetarian diet is significantly lower than the level of vitamin B12 in pregnant women consuming meat and meat products [7,11,12,13,14,15]. One of these research papers also noted that it is much more probable that the lower levels of vitamin B12 in the blood serum of pregnant living on a vegetarian diet is correlated mainly with high levels of total homocysteine present in ovo-lacto vegetarians than women consuming meat and meat products [7,11,12,13,14,15].

Simultaneously, the analyzed studies showed no occurrence of statistically significant differences between the level of zinc in pregnant women subsisting on a vegetarian diet and in pregnant women who consume meat and animal products. However, it indicated that in pregnant vegetarians who consume large amounts of calcium, there is a slightly greater risk of zinc deficiency than in women who consume meat. This threat occurs mainly due to the interactions taking place between phytate, calcium and zinc [7,11,12,13,14,15].

Based on limited scientific evidence it is also possible to declare that for certain groups of vegetarians the level of phytate in blood serum may be significantly higher than the level recorded in people consuming the meat. It should be noted at this point that there is not much evidence for this dependence [7,11,12,13,14,15].

#### **Nutrition habits of pregnant vegetarians regarding consumption of macronutrients**

It was also decided to analyze the results of comparative research relating to the eating habits of pregnant women living on a vegetarian diet, especially in the context of the amounts of ingested macronutrients. Ten scientific reports were chosen to compare. Of these, only two studies were conducted in the United States and the whole referred to the eating habits of pregnant vegetarians living there. The following studies were subjected to comparative analysis: Campbell-Brown (1985), Drake (1998), Ganpule (2006), Cheng (2004), Ellis (1987), King (1981), Koebnick (2001, 2004, 2005), and Ward (1988) [7,8,9,11,12,13,14,15,16,17].

Based on the results obtained from the studies mentioned above, it is possible to indicate the nutrients for which there are noted differences in the consumed amounts among pregnant women following a vegetarian diet and pregnant women consuming meat and animal products. These nutrients include vitamin B12,



vitamin C, calcium and zinc [7,8,9,11,12,13,14,15,16,17]. The deficiency of vitamin B12 in the diet of vegetarians follows mainly from the fact that none of the commercially available products of plant origin, if it is not supplemented with vitamin B12 it does not contain such amounts which could provide the daily needs for this vitamin. On the other hand, the deficiency of calcium and zinc in the diet of pregnant vegetarians may result from the interactions between these elements. These interactions appear mainly in people who do not consume or consume very small quantities of meat and animal products [7,8,9,11,12,13,14,15,16,17].

Additional analyzes also showed that pregnant women following a vegetarian diet may be prone to iron and folic acid deficiency. It should, however, be noted that classification of the results of studies on pregnant subsisting on a vegetarian diet depends to large degree on the country in which the surveys were conducted, and the values specified for the Guideline Daily Amount (GDA) accepted there [7,8,9,11,12,13,14,15,16,17].

#### **Difference in state of health of newborn infants born to women living on vegetarian diet and state of health of newborns born to women who eat meat and animal products**

In order to indicate whether there is a difference in the state of health of newborns born to women subsisting on a vegetarian diet during pregnancy, and women who consumed the meat and meat products during this period, four prospective cohort studies were identified and analyzed. In these studies we examined the relationship between the intake of macronutrients by women during pregnancy and the health of her child. To assess the state of child health, the researchers chose parameters such as weight and body length. The analyzes included the following studies: Campbell-Brown (1985), Drake (1998), Ganpule (2006), North and Golding (2000) [7,8,9,18].

It should be pointed out that none of the selected scientific studies focused on either the intake of individual nutrients by vegans or the state of health of their children. Analysis and comparison of the results obtained by the researchers showed that in terms of the health of newborns born to women following a vegetarian diet, and women consuming meat and meat products, there were no significant differences [7,8,9,18]. The parameters of the health of infants analyzed by the researchers, which are the mass and the length of their bodies at birth, are similar in both compared groups. This means that the body weight of infants born to women existing on a vegetarian diet during pregnancy varies in the same range as the weight of infants born to women who consumed meat and meat products during pregnancy. Similar results

were obtained when the researchers compared the length of the body of the infants at birth – both in the case of neonates born to vegetarians and infants born to women who eat meat, the length of their bodies in the vast majority of cases was within normal limits [7,8,9,18].

## **DISCUSSION**

The results of analyzes based on scientific evidence suggests, therefore, that subsisting on a vegetarian diet during pregnancy can meet the nutritional needs of women in this particular period of their life. In addition, following a properly balanced vegetarian diet provides a positive state of health of infants [6]. Vitamin B12, vitamin D, iron and folic acid are among the nutrients that are essential in normal pregnancy and fetal development. Additionally during the lactation period it is important to maintain a sufficient intake of dietary components such as vitamin B12, vitamin D, calcium, and zinc. Therefore, the diet of pregnant women and breastfeeding mothers who live on a vegetarian diet should contain rich sources of vitamins, with a particular focus on vitamin B12 [4].

As emphasized by specialists, irrespective of the chosen diet, proper synthesis of vitamin D in women during pregnancy and breastfeeding is a concern. This is due mainly to the limited exposure to sunlight, skin tone of the mother, season, and applied sunscreen. In connection with this, it is recommended that pregnant and lactating women should receive vitamin D in the form of supplements or products fortified with it. Vitamin D levels in the group of pregnant vegetarians was not determined in any of the studies included in the analyzes, making it impossible to determine whether vitamin D levels in pregnant vegetarians and women eating meat is similar or maybe significantly different in these groups of women [19]. Iron also plays an important role in the proper course of pregnancy and normal fetal development. Supplementation of this element may be necessary for the prevention or treatment of anemia caused by iron deficiency, which is very often diagnosed in pregnant women regardless of the diet they have. Therefore, increasing the supply of iron in the diet of pregnant women regardless of whether they live on a vegetarian diet or a typical diet containing meat and meat products is recommended [20,21].

Experts from the American Dietetic Association recommend, therefore, that all women of reproductive age, regardless of the followed diet, consume daily 400 micrograms of folic acid in supplements, fortified foods, or both forms simultaneously. Diet supplementation with folic acid is particularly important because of the importance of this element in the proper deve-



lopment of the neural tube in the fetus [22]. The demand for zinc and calcium in the diet of pregnant women can successfully be ensured by eating foods enriched with calcium and zinc or supplements containing these elements [23].

An appropriate supply of docosahexaenoic acid (DHA) plays an important role during pregnancy and breastfeeding. Neonates born to women subsisting on a vegetarian diet during pregnancy may have lower levels of DHA in the umbilical cord blood and plasma than infants born to women who consumed meat and meat products during pregnancy [24]. In the milk of mothers having a vegetarian diet, especially ovo-lacto vegetarian and vegan, there are lower levels of DHA than in the milk of women eating meat. As emphasized by specialists, docosahexaenoic acid has a positive impact not only on the sustainability of pregnancy, but also on the healthy development of children's sight and their correct neurological development. Therefore, experts from the American Dietetic Association recommend that vegetarians and vegans during pregnancy and breastfeeding should enrich their diet with products which are a rich source of docosahexaenoic acid (DHA). Food supplemented with DHA, the eggs of hens fed with microalgae rich in DHA, as well as DHA supplements composed on the basis of microalgae are good sources of DHA.

Equally important is the supplementation of ALA, which is the precursor of DHA. However, experts point out that this supplementation for pregnant and breast-feeding women may be ineffective, especially in terms of increased levels of DHA in newborns and increased concentration of DHA in breast milk [18].

Infants born to women following a vegetarian diet, who consume the right amount of milk or milk replacer develop in a proper manner, and the pace of their development is not different from the rate of development of infants born to women who eat meat. After the introduction of solid foods to their diet, the correct growth of infants of vegetarians can be ensured by providing them with good sources of energy and nutrients. Researchers so far have not undertaken analysis of the safety of infants and children of extremely restrictive diets such as a fruitarian diet or raw vegan diet. In the opinion of experts such diets can very adversely affect the development of infants and young children through their possibly very poor supply of energy and the supply of such important nutrients in the diet as protein, some vitamins and minerals. Therefore, these diets are not recommended in the nutrition of infants and young children [19].

The practice of breastfeeding is very common among women living on a vegetarian diet. In this respect it should be promoted and supported. It should also be emphasized that the milk of women following this diet has a similar composition to the milk of mothers consuming meat and meat products. This means that it

meets the nutritional needs of newborns and infants [4].

In such a situation, the use of formulas is the better option only when the babies for some reason are not or cannot be breastfed and infants who are being weaned from the mother before the age of one year old. In the case of women having a vegan diet who want to convey to their children this diet, the only substitute for breast milk is soy milk replacer. It should also be noted at this point that other alternatives such as soy milk, rice milk or their products must not be used in the home as a substitute for breast milk or commercially available milk replacers [4].

Solid foods should be introduced into the diet of children of women subsisting on a vegetarian diet at the same rate as in the case of children of women who consume meat. The introduction of solid foods in vegetarian children requires replacing meat by tofu or legumes put through a strainer. In place of meat, mothers can also feed their baby soy yogurt, or cow's milk with boiled egg yolks and cream cheese. Between 7 and 10 months of age, it is possible to include in the diet diced tofu, cheese, soy cheese, or a veggie burger cut into small pieces. At this point, it should be emphasized also that full-fat, fortified soy milk or pasteurized cow's milk may become the primary beverage of a child aged 1 year old, and whose development is correct [25].

When the child is breastfed it is advisable to feed him foods rich in energy and nutrients. For this purpose legume spreads, tofu and crushed avocado can be served. Limiting fat intake is not advisable for children under 2 years of age. On the other hand, supplementation is advisable – in both vegetarian as well as non-vegetarian children. If there is a high risk of vitamin B12 deficiency, infants fed breast milk should receive supplements [25].

It is also necessary to estimate the consumption of zinc in the diet of infants, and in case of risk of deficiency, give supplements to a child, especially during the introduction of supplementary products for mother's milk, or baby when feeding him food of a low bioavailability of this element [4].

Dietary counseling plays very important role in the case of following a vegetarian diet among pregnant women and in the case of carrying out this method of feeding infants and young children. Dietary counseling is especially important for vegetarians who show symptoms of concrete, although not yet defined health problems associated strictly with an improperly balanced diet. The role of the nutritionist in the context of taking up a vegetarian diet, with clinical forms of the diseases requiring additional dietary modifications is very significant [4]. Diseases such as diabetes, hyperlipidemia, and kidney disease are primarily mentioned in this case. Depending on the level of knowledge about the vegetarian diet, acquired by the person who



follows it, dietary advice is especially recommended for people who have recently decided to start following a vegetarian diet, people at different stages of life, planning to become pregnant, during pregnancy, recently having given birth and have children in the preschool and early school age, have children in adolescence, or completed their occupational activity.

Opponents of vegetarian diets rely on the arguments that existing on a vegetarian diet, especially its restrictive varieties, may cause adverse nutritional and health effects [1]. The most commonly reported negative health effects characteristic of a vegetarian diet include: protein deficiency, calcium deficiency, iron, vitamin D, vitamin B12, the harmful effects of substances used to protect plants on the human body, as well as the negative impact of anti-nutritional substances on the human body [26].

The fact that in the opinion of some experts rigorous varieties of vegetarian diets, particularly vegan, can result in impaired normal human development in the most important periods of one's life is also significant. The American Dietetic Association (2009) [4] and the Academy of Nutrition and Dietetics (2016) [27] in relation to vegetarian diets confirms that being properly planned, it is healthy and can bring health benefits in the form of the prevention and treatment of certain diseases. It is suitable for all phases of the life cycle, including pregnancy, lactation, infancy, childhood, adolescence, old age and for athletes. Vegetarians and vegans are able to reduce the risk of certain diseases including ischemic heart disease, type 2 diabetes, hypertension, certain types of cancer and obesity. A low intake of saturated fats and large amounts of vegetables, fruits, whole grains, legumes, soy products, nuts and seeds are characteristic of vegetarian and vegan diets, causing lower cholesterol levels and better control of blood glucose. The Academy of Nu-

trition and Dietetics [27] notes that vegans need reliable sources of vitamin B12 from fortified foods or supplements, as confirmed by the study by Piccoli et al. [28], suggesting nutritional deficiencies in pregnant women, mainly in iron, vitamin B12 and D and calcium intake.

That is why it is important to present as reliable as possible knowledge and to continue improving people's state of consciousness of in both the positive and negative health effects of vegetarian diets [26].

## CONCLUSIONS

A properly designed vegetarian diet can be followed by pregnant women without risk for the fetus.

In addition, the study showed that:

1. A difference between the demand for energy and macronutrients in the group of pregnant vegetarian diets, and in the group of pregnant women consuming meat practically does not exist.
2. The bioavailability of the vast majority of macronutrients in the pregnant vegetarian diet is the same as in the diet of pregnant women consuming meat. The macronutrients which are quoted in the case of reduced bioavailability refer primarily to vitamin B12 and iron.
3. The nutritional habits of pregnant vegetarians relating to the consumption of macronutrients are correct. Pregnant women subsisting on a vegetarian diet strive to provide the organism with all necessary nutrients, minerals and vitamins.
4. The nutritional status of infants born to women living on a vegetarian diet does not differ from the state of infants born to women eating meat.

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### Author's contribution

Study design – M. Olejniczak-Nowakowska

Data collection – M. Mazur, Ż. Grochowska

Data interpretation – M. Olejniczak-Nowakowska, G. Krasowski

Statistical analysis – M. Olejniczak-Nowakowska, K. Krupa-Kotara

Manuscript preparation – M. Olejniczak-Nowakowska, K. Krupa-Kotara

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Final approval of the version to be published – M. Olejniczak-Nowakowska, K. Krupa-Kotara

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