Review paper

# Eating habits and nutritional status of pregnant women and the course and outcomes of pregnancy

## *Sposób żywienia i stan odżywienia kobiet ciężarnych a przebieg ciąży i wskaźniki urodzeniowe noworodków*

Edyta Suliga

Department of the Prevention of Alimentary Tract Diseases, Jan Kochanowski University, Kielce, Poland
Head of the Department: Prof. Grażyna Rydzewska MD, PhD

Studia Medyczne 2015; 31 (1): 60–65
DOI: 10.5114/ms.2015.49955

**Key words:** pre-term birth, preeclampsia, gestational diabetes, macrosomia, low birth weight.

**Słowa kluczowe:** poród przedwczesny, preeklampsja, cukrzyca ciążowa, makrosomia, mała masa urodzeniowa.

**Abstract**

The eating habits and nutritional status of future mothers have an important effect, not only on the course of pregnancy and the development of the foetus, but also on the health of the children during subsequent years of life. The objective of the study was the analysis of the relationship between eating habits and nutritional status of pregnant women on the course of pregnancy and pregnancy outcomes, based on a literature review. In the presented study the following are discussed: nutritional risk factors of pre-term birth, gestational diabetes, preeclampsia, low birth weight, infants born small for gestational age, as well as macrosomia and babies born large for gestational age. In the analysis, data was used concerning the consumption of individual products, groups of products, and dietary patterns, without consideration of dietary supplementation.

**Streszczenie**

Sposób żywienia i stan odżywienia przyszłych matek mają istotny wpływ nie tylko na przebieg ciąży i rozwój płodu, lecz także na zdrowie ich dzieci w kolejnych latach życia. Celem pracy była analiza zależności między sposobem żywienia i stanem odżywienia kobiet ciężarnych a przebiegiem ciąży i wskaźnikami urodzeniowymi noworodków na podstawie przeglądu piśmiennictwa. W pracy omówiono żywieniowe czynniki ryzyka porodu przedwczesnego, cukrzycy ciążowej, preeklampsji, małej masy urodzeniowej i małej masy w stosunku do wieku płodowego oraz makrosomii i dużej masy w stosunku do wieku płodowego. W analizie wykorzystano dane dotyczące spożycia poszczególnych produktów, grup produktów oraz wzorów żywieniowych bez uwzględniania suplementacji.

## Introduction

Contemporary scientific studies indicate the presence of close relationships between consumed food products and the nutrients contained in these products, and normal human development and health. Knowledge in this area is becoming increasingly comprehensive, especially from the aspect of prevention of diseases developing as a result of inadequate nutrition. In the last decade of the 20$^{th}$ century there emerged a concept concerning intrauterine programming of the risk of cardiovascular diseases, type 2 diabetes, hypertension, and dyslipidaemia in individuals born with low birth weight, especially with intrauterine foetal growth inhibition. In the development of these disorders, the role of malnutrition of the mother is especially indicated, both prior to and during pregnancy. Also, excessive nutrition of the mother, related with her obesity and/or higher than recommended gestational weight gains, seems to play an important role in the programming of the risk of cardiovascular diseases and type 2 diabetes in individuals born with high body weight [1]. This risk was independent from the impact of other risk factors in later life. Thus, eating habits and nutritional status of future mothers exert an important effect, not only on the course of pregnancy and development of the foetus, but also on the health of the children during subsequent years of life.

The objective of the study was the analysis of the relationship between eating habits and nutritional status of pregnant women on the course of pregnancy and pregnancy outcomes, based on a literature review.

In the presented study the following are discussed: nutritional risk factors of pre-term birth, gestational diabetes, preeclampsia, low birth weight (LBW), infants born small for gestational age (SGA), as well as macrosomia and babies born large for gestational age (LGA). A review of reports available in the PubMed database during the last 10 years (2005–2014) was performed. In further analysis, data was used concerning the consumption of individual products, groups of products, and dietary patterns, without consideration of dietary supplementation. Also, the results of studies were presented concerning food contamination. The analysed literature was limited mainly to the results of studies conducted in developed countries. Different problems related with the specificity of nutrition and state of health of pregnant women resulting from poverty and lower level of health care in developing countries might have disturbed the analysed relationships.

## Pre-term birth

The risk of pre-term birth may be increased by both underweight and excess body weight prior to pregnancy and abnormal gestational body gains. The majority of studies show relationships between low gestational body weight gains and pre-term delivery among women who are underweight, and to a slightly lower degree, among those with normal weight. In turn, high gestational body weight gains may be associated with pre-term delivery in all body mass index (BMI) categories [2–5].

Also, the presence of many relationships was discovered between the mode of nutrition of the mother during pregnancy and pre-term birth. A study conducted in Denmark in a group of 60,000 women showed that the 'Western' diet, with a large amount of meat and fat, low in fruits and vegetables, increased the risk of pre-term delivery [6]. This risk was also related with daily consumption of artificially sweetened beverages [7]. The researchers noted that it is difficult to specify which of the sweeteners might have been the cause of this phenomenon. The majority of beverages contained a mixture of various sweeteners, most often aspartame and acesulphame. Many studies have confirmed that aspartame metabolites may disturb the metabolism of amino acids and the functions of neurones, change the brain concentrations of catecholamines, and have a carcinogenic effect [8, 9]. A prospective study carried out in Norway on a group of more than 60,000 women indicated that the risk of pre-term birth may be increased by high consumption (> 1 portion daily) of both artificially sweetened beverages and beverages sweetened with sugar [10]. In pregnant women whose diet was balanced and contained an appropriate amount of vegetables, fruits, full-grain products, fish, and drinking water, the risk of occurrence of pre-term birth was significantly lower [11]. It was also found that increased consumption of 'healthy' products was more important than total exclusion from the diet of processed food, fast foods, and snacks. A study of 151,880 mother-child pairs in cohort population studies conducted in 19 European countries confirmed that women who in pregnancy consumed fish more frequently than once a week were at lower risk of pre-term delivery than those who consumed fish once a week or more rarely [12]. Among factors increasing the risk of pre-term birth is also the consumption of alcoholic beverages in pregnancy. A prospective study conducted in the United Kingdom showed that, compared to women who abstained from alcohol, those who consumed alcohol in the first trimester of pregnancy in the amount of up to two portions of alcohol weekly, the odds ratio of occurrence of pre-term delivery was odds ratio (OR) = 3.5 (95% CI: 1.1–11.2), and in those who consumed > 2 portions of alcohol a week this risk was OR = 4.6 (95% CI: 1.4–14.7) [13].

## Gestational diabetes

Gestational diabetes is one of the causes of abnormalities in the course of pregnancy and foetal development. Complications of pregnancy related with gestational diabetes include, among others, intrauterine death, pre-term birth, foetal hypoxia, and developmental defects. According to the recommendations by the Polish Diabetological Society, the diet of a pregnant woman with gestational diabetes should not considerably differ from the standard mode of nutrition recommended to diabetic patients; however, in women who are overweight a low-calorie diet is recommended [14].

Literature reviews published in 2010 and 2011 confirmed that to date it is not possible to draw definite conclusions concerning the role of nutritional factors during pregnancy in the development of gestational diabetes [15, 16]. It was only observed that an increased risk of gestational diabetes was related with high pre-pregnancy BMI and high gestational weight gains, as well as a high content of fat in the diet and a low content of carbohydrates. The application in a randomised study of a diet with reduced content of carbohydrates in the group of women with gestational diabetes (40% of energy from carbohydrates in the diet of the study group vs. 55% in the control group) did not result in a decrease in the number of women who needed insulin, nor affected pregnancy outcomes [17]. The subsequent reports showed that the dietary approaches to stop hypertension (DASH) diet applied by women with gestational diabetes had a favourable effect on fasting glucose level, insulin level, and the value of the homeostatic model assessment of insulin resistance (HOMA-IR) index, as well as a decrease in the body weight of newborns, compared to the control group (3,222.7 g vs. 3,818.8 g) [18, 19].

Nevertheless, many factors were identified related with an increased risk of gestational diabetes in the pre-pregnancy period. The risk was increased by a diet low in fibre, with a high glycaemic load [20]. In women who consumed > 2 portions of fast food/week, > 3 portions/month up to ≤ 2 portions/week, and 0–3 portions/month, the risk of development of gestational diabetes was 6.7%, 4.8%, and 3.9%, respectively [21]. A higher consumption of animal fat, especially red meat, was significantly related with the occurrence of gestational diabetes, whereas a higher consumption of plant proteins, especially nuts, was associated with a considerably lower risk [22]. Frequent consumption of fried products also increased the risk of gestational diabetes, especially when consumed ≥ 7 times weekly [23]. The adherence, before pregnancy, to the principles of the Mediterranean diet, DASH diet, and the Healthy Eating Index (HEI) was related with a lower relative risk of diabetes by 24%, 34%, and 46%, respectively [24]. In a prospective study, it was found that four components of health-promoting lifestyle before pregnancy, such as: maintenance of normal body weight, healthy diet, regular exercise, and non-smoking, were associated with a lower risk of development of gestational diabetes by 80%, compared to women who did not observe any of these principles [25].

## Preeclampsia

Preeclampsia is a multisystem disorder of pregnancy, which concerns 3–5% of pregnancies in developed countries. It may lead to serious complications, both in the mother and the foetus: eclampsia, disorders of renal and hepatic function, as well as disorders concerning the coagulation system, acute respiratory distress syndrome (ARDS), intrauterine growth inhibition, placental abruption, and foetal hypoxia. Women with diabetes, insulin resistance, lipid disorders, obesity, chronic hypertension, and those exposed to stress are especially at risk of development of preeclampsia. The results of the analysed studies indicate that the risk of preeclampsia in pregnant women is increased by overweight and obesity [26], high consumption of processed meat, sweet beverages and salty snacks [27], and generally high consumption of sugar-rich foods [28]. The reduced risk of preeclampsia was related with a diet containing a large amount of fish and polyunsaturated fatty acids (PUFA) n-3 [29], higher contents of nutritional fibre [30], lower caloric value, rich in vegetables and fruits, as well as magnesium and calcium [31], and a diet containing ecological vegetables [32]. According to the researchers, the selection of ecological vegetables in pregnancy was associated with lower exposure to pesticides, secondary plant metabolites, and the effect on the composition of intestine microflora.

## Low birth weight and small for gestational age

The risk of bearing a baby with LBW or SGA was related primarily with underweight before pregnancy and low gestational weight gains, and the risk was especially high when these two factors occurred jointly [2, 33]. Among LBW and SGA risk factors related with nutrition in pregnancy was low content of iron in diet, increasing the risk of anaemia [34, 35]. The subsequent factor was an unfavourable fatty acids profile in early pregnancy [36]. Low content of n-3 acids and dihomo-γ-linolenic acid (20 : 3 n-6), which is a precursor of arachidonic acid (20 : 4 n-6), and high content of other fatty acids of the n-6 family, and trans isomers in the diet of the mother, were associated with low birth weight of newborns.

The risk of low birth weight increased in mothers who consumed 6 or more portions of caffeine daily (1 portion = 90 mg caffeine) [37]. In another study, an increased risk of SGA was observed already with the consumption of caffeine 200–300 mg/daily, compared to 0–50 mg/daily [38]. Data concerning the relationship between the consumption of alcohol in pregnancy and the risk of LBW or SGA are inconsistent. A meta-analysis published in 2011 showed that low or moderate consumption of alcohol (up to 10 g/daily) did not increase the risk of LBW and SGA, and this risk occurred only in the case of heavy alcohol consumption [39]. The subsequent study indicated that the risk of SGA was OR = 1.7 in the case of consumption in the first trimester < 2 alcohol units/weekly (1 unit = 10 ml pure alcohol), and OR = 2.0 in the case of > 2 units/weekly, compared to the abstinents [13].

Duarte-Salles *et al*. found that a high content of acrylamide in the diet of pregnant women was related with a higher risk of LBW and SGA [40]. In populations not exposed occupationally and non-smokers, the main source of acrylamide is diet. It is produced during boiling at high temperatures (for example, while frying, barbecuing, or baking), especially of products rich in carbohydrates that contain the amino acid asparagine and reducing sugars. The consumption of dioxins and polychlorinated biphenyls during pregnancy, even when lower than the tolerable weekly intake (TWI), was negatively related with foetal growth [41]. The results of studies indicate that higher prenatal exposure to dietary benzo(a)pyrene may reduce birth weight [42].

It was also discovered that the risk of low birth weight may increase in the case of increased exposure to mercury, the main source of which is fish. Newborns with the highest amount of mercury in umbilical cord blood showed a higher risk of low weight in relation to gestational age (OR = 5.3), and weighed 143.7 g less on average, compared to newborns remaining within the lowest quartile with respect to the amount of mercury [43]. In many other studies, high consumption of fish and seafood was associated with reduced LBW/SGA risk [44, 45]. Thus, the results of studies indicate that the role of fish in the diet of pregnant women is controversial. On the one hand, they are recommended due to high contents of PUFA, complete protein, vitamins A and D, copper, iodine, cobalt, and selenium, but on the other hand, they constitute the main source of mercury, showing a toxic effect. The role of fish in the development of the foetus depends, to a large extent, on the amount and type of fish consumed [43]. Long-living predatory fish are the most contaminated with mercury compounds. Recently, a report has been published in which 151,880 mother-baby pairs from 19 European countries were analysed. The analysis showed that women who consumed fish more often (1–2 times a week) gave birth to children with body weight 8.9 g higher, and with consumption ≥ 3 times a week, with body weight 15.2 g higher, irrespective of gestational age [12]. A pilot randomised study carried out in the USA confirmed that educational intervention applied in pregnant women who consumed low amounts of fish at the beginning of the study contributed to an increase in the consumption of fish, with high content of DHA and low content of mercury. In women from the intervention group, despite a considerable increase in the consumption of fish, an elevated level of mercury in blood and hair was noted [46].

The risk of LBW/SGA was also reduced by high consumption of milk and dairy products [47, 48], vegetables [49–51], and in some studies, fruit [49, 51] and iron [52]. A positive correlation was also found between birth weight and level of magnesium and vitamins D, $B_{12}$, biotin, and pantothenic acid in the diet of pregnant women [53].

The risk of giving birth to a baby with macrosomia or LGA was related mainly with high pre-pregnancy BMI, high gestational weight gains, and gestational diabetes [2, 33, 54]. Alberico *et al.*, in their study conducted in a group of over 14,000 women, showed that the risk of bearing a baby with macrosomia was 1.7-fold higher in obese women, compared to those with a normal body weight, 1.9-fold higher in women with gestational weight gains higher than recommended, and 2.1-fold higher in women with gestational diabetes [54]. The subsequent risk factor was a high consumption of milk, which contributed to an increase in the concentration of IGF-1 in blood – an important factor determining growth [55]. A higher risk of bearing a baby with macrosomia/LGA was also associated with a high percentage of energy supplied by sweets [56], and a high glycaemic load diet [57]. The birth weight of babies of mothers who remained within the highest quintile of dietary glycaemic load was 36 g higher, on average, compared to the weight of children of mothers from the lowest quintile, while the risk of bearing a LGA baby was by 14% higher among mothers in the highest quintile of dietary glycaemic load, compared to those with the lowest load [57]. A high glycaemic load diet and a high percentage supplied by saturated fatty acids were additionally related with a greater amount of central fat in newborns [58].

## Summing up

The results of the presented study show important benefits resulting from the application of a healthy diet by women at reproductive age and those who are pregnant. Health education in the area of adequate diet should be an integral part of medical services provided for pregnant women and those who plan pregnancy, and should constitute one of the priorities of the health policy of the State.

Special attention should be paid to the maintenance of normal body weight and control of gestational weight gains. These are the main indicators of adequate nutrition, both in the preconception period and during pregnancy, and their abnormal values are related with an increased risk of the occurrence of such problems as: gestational diabetes, preeclampsia, premature birth, abnormal birth weight, and other disorders in the development of the foetus. Normal body weight should be maintained by balancing the caloric value of the diet with adequate physical activity. During pregnancy gestational weight gains should be adjusted to the BMI value before pregnancy [2]. Cereal products should be the main source of calories in the diet of pregnant women. Whole grains, compared to refined grains, have a lower glycaemic index; therefore, their proper consumption facilitates maintenance of normal weight, and is very important in the prophylaxis and treatment of diabetes and the prevention of giving birth to a baby with macrosomia or one that is large for gestational age. For the same reason, the consumption of sugar and sweets should be limited. The majority of ready-made confectionary additionally contains considerable amounts of trans isomers of fatty acids, which are disadvantageous in pregnancy. Meat and its products should be consumed in moderation. In the 2nd and 3rd trimester of pregnancy it is recommended to consume lean meat or cold cuts in the amount of 200–250 g daily [59]. Twice a week, a portion of meat products should be replaced by a portion of oily sea fish. However, due to its high content of mercury, the consumption of long-living predatory fish should be avoided. Once or twice weekly it is recommended to eat meals prepared from the seeds of leguminous plants. A woman in pregnancy should consume three portions of low-fat milk and low-fat dairy products in the 1st trimester, and four portions in the 2nd and 3rd trimesters. Proper consumption of fruit and vegetables is also very important. In the 2nd and 3rd trimesters, pregnant women should consume approx. 400 g of fruit and 600 g of vegetables (including 200 g of potatoes) [59]. In pregnancy it is necessary to resign from the consumption of alcoholic beverages and limit the consumption of coffee and strong tea, and thirst should be quenched with water.

## Conflict of interest

The authors declare no conflict of interest.

## References

1. Szostak-Węgierek D, Szamotulska K. Fetal development and risk of cardiovascular diseases and diabetes type 2 in adult life. Dev Per Med 2011; 15: 203-15.
2. Rasmussen KM, Yaktine AL (eds). Weight gain during pregnancy: reexamining the guidelines. Institute of Medicine, National Research Council of the National Academies, Washington D.C. 2009.
3. McDonald SD, Han Z, Mulla S, et al. High gestational weight gain and the risk of preterm birth and low birth weight infants: a systematic review and meta-analysis. J Obstet Gynaecol Can 2011; 33: 1223-33.
4. Khatibi A, Brantsæter AL, Sengpiel V, et al. Prepregnancy maternal body mass index and preterm delivery. Am J Obstet Gynecol 2012; 207: 212.1-7.
5. Masho SW, Bishop DL, Munn M. Pre-pregnancy BMI and weight gain: where is the tipping point for preterm birth? BMC Pregn Childbirth 2013; 13: 120.
6. Rasmussen MA, Maslova E, Halldorsson TI, et al. Characterization of dietary patterns in the Danish national birth cohort in relation to preterm birth. PLoS One 2014; 9: e93644.
7. Halldorsson TI, Strøm M, Petersen SB, et al. Intake of artificially sweetened soft drinks and risk of preterm delivery: a prospective cohort study in 59,334 Danish pregnant women. Am J Clin Nutr 2010; 92: 626-33.
8. Humphries P, Pretorius E, Naudé H. Direct and indirect cellular effects of aspartame on the brain. Eur J Clin Nutr 2008; 62: 451-62.
9. Rycerz K, Jaworska-Adamu JE. Effects of aspartame metabolites on astrocytes and neurons. Folia Neuropathol 2013; 51: 10-7.
10. Englund-Ögge L, Brantsæter AL, Haugen M, et al. Association between intake of artificially sweetened and sugar-sweetened beverages and preterm delivery: a large prospective cohort study. Am J Clin Nutr 2012; 96: 552-9.
11. Englund-Ögge L, Brantsæter AL, Sengpiel V, et al. Maternal dietary patterns and preterm delivery: results from large prospective cohort study. BMJ 2014; 348: g1446.
12. Leventakou V, Roumeliotaki T, Martinez D. Fish intake during pregnancy, fetal growth, and gestational length in 19 European birth cohort studies Am J Clin Nutr 2014; 99: 506-16.
13. Nykjaer C, Alwan NA, Greenwood DC, et al. Maternal alcohol intake prior to and during pregnancy and risk of adverse birth outcomes: evidence from a British cohort. J Epidemiol Community Health 2014; 68: 542-9.
14. Zalecenia kliniczne dotyczące postępowania u chorych na cukrzycę. Diabetol Klin 2012; 1 (supl. A): 1-52.
15. Morisset AS, St-Yves A, Veillette J, et al. Prevention of gestational diabetes mellitus: a review of studies on weight management. Diabetes Metab Res Rev 2010; 26: 17-25.
16. Zhang C, Ning Y. Effect of dietary and lifestyle factors on the risk of gestational diabetes: review of epidemiologic evidence. Am J Clin Nutr 2011; 94 (Suppl): 1975-9.
17. Moreno-Castilla C, Hernandez M, Bergua M, et al. Low-carbohydrate diet for treatment of gestational diabetes mellitus. Diabet Care 2013; 36: 2233-8.
18. Asemi Z, Samimi M, Tabasi Z, et al. A randomized controlled clinical trial investigating the effect of DASH diet on insulin resistance, inflammation, and oxidative stress in gestational diabetes. Nutrition 2013; 29: 619-24.
19. Asemi Z, Samimi M, Tabasi Z, et al. The effect of DASH diet on pregnancy outcomes in gestational diabetes: a randomized controlled clinical trial. Eur J Clin Nutr 2014; 68: 490-5.
20. Zhang C, Liu S, Solomon CG, et al. Dietary fiber intake, dietary glycemic load, and the risk for gestational diabetes mellitus. Diabetes Care 2006; 29: 2223-30.
21. Dominguez LJ, Martínez-González MA, Basterra-Gortari FJ, et al. Fast food consumption and gestational diabetes incidence in the SUN Project. PLoS ONE 2014; 9: e106627.
22. Bao W, Bowers K, Tobias DK, et al. Prepregnancy dietary protein intake, major dietary protein sources, and the risk of gestational diabetes mellitus: a prospective cohort study. Diabetes Care 2013; 36: 2001-8.
23. Bao W, Tobias DK, Olsen SF, et al. Pre-pregnancy fried food consumption and the risk of gestational diabetes mellitus: a prospective cohort study. Diabetologia 2014; 57: 2485-91.
24. Tobias DK, Zhang C, Chavarro J, et al. Prepregnancy adherence to dietary patterns and lower risk of gestational diabetes mellitus. Am J Clin Nutr 2012; 96: 289-95.
25. Zhang C, Tobias DK, Chavarro JE, et al. Adherence to healthy lifestyle and risk of gestational diabetes mellitus: prospective cohort study. BMJ 2014; 349: g5450.
26. Wang Z, Wang P, Liu H, et al. Maternal adiposity as an independent risk factor for pre-eclampsia: a meta-analysis of prospective cohort studies. Obes Rev 2013; 14: 508-21.
27. Brantsaeter AL, Haugen M, Samuelsen SO, et al. A dietary pattern characterized by high intake of vegetables, fruits, and vegetable oils is associated with reduced risk of preeclampsia in nulliparous pregnant Norwegian women. J Nutr 2009; 139: 1162-8.
28. Borgen I, Aamodt G, Harsem N, et al. Maternal sugar consumption and risk of preeclampsia in nulliparous Norwegian women. Eur J Clin Nutr 2012; 66: 920-5.
29. Oken E, Ning Y, Rifas-Shiman SL, et al. Diet during pregnancy and risk of preeclampsia or gestational hypertension. Ann Epidemiol 2007; 17: 663-8.
30. Qiu C, Coughlin KB, Frederick IO, et al. Dietary fiber intake in early pregnancy and risk of subsequent preeclampsia. Am J Hypertens 2008; 21: 903-9.
31. Schoenaker D, Soedamah-Muthu SS, Mishra GD. The association between dietary factors and gestational hypertension and pre-eclampsia: a systematic review and meta-analysis of observational studies. BMC Medicine 2014; 12: 157.
32. Torjusen H, Brantsæter AL, Haugen M, et al. Reduced risk of pre-eclampsia with organic vegetable consumption: results from the prospective Norwegian Mother and Child Cohort Study. BMJ Open 2014; 4: e006143.
33. Haugen M, Brantsæter AL, Winkvist A, et al. Associations of pre-pregnancy body mass index and gestational weight gain with pregnancy outcome and postpartum weight retention: a prospective observational cohort study. BMC Pregn Childbirth 2014; 14: 201.
34. Haider BA, Olofin I, Wang M, et al. Anaemia, prenatal iron use, and risk of adverse pregnancy outcomes: systematic review and meta-analysis. BMJ 2013; 346: f3443.
35. Stanowisko Zespołu Ekspertów Polskiego Towarzystwa Ginekologicznego w sprawie profilaktyki niedoboru żelaza oraz niedokrwistości z niedoboru żelaza niską dawką żelaza hemowego u kobiet – stan wiedzy na 2013 rok. Ginekol Pol 2014; 85: 74-8.

36. van Eijsden M, Hornstra G, van der Wal MF, et al. Maternal n-3, n-6, and trans fatty acid profile early in pregnancy and term birth weight: a prospective cohort study. Am J Clin Nutr 2008; 87: 887-95.
37. Bakker R, Steegers EAP, Obradov A, et al. Maternal caffeine intake from coffee and tea, fetal growth, and the risks of adverse birth outcomes: the Generation R Study. Am J Clin Nutr 2010; 91: 1691-8.
38. Sengpiel V, Elind E, Bacelis J, et al. Maternal caffeine intake during pregnancy is associated with birth weight but not with gestational length: results from a large prospective observational cohort study. BMC Medicine 2013; 11: 42.
39. Patra J, Bakker R, Irving H, et al. Dose-response relationship between alcohol consumption before and during pregnancy and the risks of low birth weight, preterm birth and small-size-for-gestational age (SGA) – A systematic review and meta-analyses. BJOG 2011; 118: 1411-21.
40. Duarte-Salles T, von Stedink H, Granum B, et al. Dietary acrylamide intake during pregnancy and fetal growth - results from the Norwegian mother and child cohort study (MoBa). Environ Health Perspect 2013; 121: 374-9.
41. Papadopoulou E, Caspersen IH, Kvalem HE, et al. Maternal dietary intake of dioxins and polychlorinated biphenyls and birth size in the Norwegian Mother and Child Cohort Study (MoBa). Environ Int 2013; 60: 209-16.
42. Duarte-Salles T, Mendez MA, Meltzer HM, et al. Dietary benzo(a)pyrene intake during pregnancy and birth weight: associations modified by vitamin C intakes in the Norwegian Mother and Child Cohort Study (MoBa). Environ Health Perspect 2013; 60: 217-23.
43. Ramón R, Ballester F, Aguinagalde X, et al. Fish consumption during pregnancy, prenatal mercury exposure, and anthropometric measures at birth in a prospective mother-infant cohort study in Spain. Am J Clin Nutr 2009; 90: 1047-55.
44. Oken E, Kleinman K, Olsen S, et al. Associations of seafood and elongated n-3 fatty acid intake with fetal growth and length of gestation: results from a US pregnancy cohort. Am J Epidemiol 2004; 160: 774-83.
45. Brantsæter AL, Birgisdottir BE, Meltzeret HM, et al. Maternal seafood consumption and infant birth weight, length and head circumference in the Norwegian Mother and Child Cohort Study. Br J Nutr 2012; 107: 436-44.
46. Oken E, Guthrie LB, Bloomingdale A, et al. A pilot randomized controlled trial to promote healthful fish consumption during pregnancy: The Food for Thought Study. Nutr J 2013; 12: 33.
47. Brantsæter AL, Olafsdottir AS, Forsum E, et al. Does milk and dairy consumption during pregnancy influence fetal growth and infant birthweight? A systematic literature review. Food Nutr Res 2012; 56: 20050.
48. Borazjani F, Angali KA, Shanuak S, et al. Milk and protein intake by pregnant women affects growth of foetus. J Health Popul Nutr 2013; 31: 435-45.
49. Mikkelsen TB, Osler M, Orozova-Bekkevold I, et al. Association between fruit and vegetable consumption and birth weight: a prospective study among 43,585 Danish women. Scand J Publ Health 2006; 34: 616-22.
50. Ramon R, Ballester F, Iniguez C, et al. Vegetable but not fruit intake during pregnancy is associated with newborn anthropometric measures. J Nutr 2009; 139: 561-7.
51. Murphy MM, Stettler N, Smith KM, et al. Associations of consumption of fruits and vegetables during pregnancy with infant birth weight or small for gestational age births: a systematic review of the literature. Int J Womens Health 2014; 6: 899-912.
52. Alwan N, Greenwood DC, Nigel AB, et al. Dietary iron intake during early pregnancy and birth outcomes in a cohort of British women. Hum Reprod 2011; 26: 911-9.
53. Watson PE, McDonald BW. The association of maternal diet and dietary supplement intake in pregnant New Zealand women with infant birthweight. Eur J Clin Nutr 2010; 64: 184-93.
54. Alberico S, Montico M, Barresi V, et al. The role of gestational diabetes, pre-pregnancy body mass index and gestational weight gain on the risk of newborn macrosomia: results from a prospective multicentre study. BMC Pregn Childbirth 2014; 14: 23.
55. Olsen SF, Halldorsson TI, Willett WC, et al. Milk consumption during pregnancy is associated with increased infant size at birth: prospective cohort study. Am J Clin Nutr 2007; 86: 1104-10.
56. Phelan S, Hart C, Phipps M, et al. Maternal behaviors during pregnancy impact offspring obesity risk. Exp Diabet Res 2011; 2011: 985139.
57. Knudsen VK, Heitmann BL, Halldorsson TI, et al. Maternal dietary glycaemic load during pregnancy and gestational weight gain, birth weight and postpartum weight retention: a study within the Danish National Birth Cohort. Br J Nutr 2013; 1: 1-8.
58. Horan MK, McGowan CA, Gibney ER, et al. Maternal low glycaemic index diet, fat intake and postprandial glucose influences neonatal adiposity – secondary analysis from the ROLO study. Nutr J 2014; 13: 78.
59. Szostak-Węgierek D, Cichocka A. Żywienie kobiet w ciąży. Wydawnictwo Lekarskie PZWL, Warsaw 2012.



**Address for correspondence:**

Prof. JKU **Edyta Suliga** PhD
Department of the Prevention of Alimentary Tract Diseases
Jan Kochanowski University
Al. IX Wieków Kielc 19, 25-317 Kielce, Poland
Phone: +48 694 898 348
E-mail: edyta.suliga@ujk.edu.pl