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Birth weight of newborns and health behaviours and haematological parameters of pregnant women – results of preliminary studies

Masa urodzeniowa noworodków a zachowania zdrowotne i wskaźniki hematologiczne kobiet w ciąży – wyniki badań wstępnych

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Abstract
In individuals born with a low birth weight an increased risk of occurrence of arterial hypertension, dyslipidemia, cardiovascular diseases, and type 2 diabetes is observed in adulthood. In individuals born with macrosomia, the risk of occurrence of type 2 diabetes and cardiovascular diseases is also noted in adulthood. Therefore, studies aimed at the identification of risk factors of intrauterine foetal growth disorders are very important. **The aim of the study.** The objective of the presented study was the evaluation of the relationship between health behaviours and haematological parameters of pregnant women, and birth weight of newborns. **Material and methods.** The materials for the study were the data concerning 274 women and their babies. Using a questionnaire, information pertaining to the place of living, the body height and weight, cigarette smoking, and the eating habits during pregnancy was collected. Information concerning pregnancy order, the course and duration of pregnancy, as well as haematological parameters were collected based on the analysis of medical records. **Results.** Women who were underweight before pregnancy more frequently gave birth to small-for-gestational age babies, whereas large-for-gestational age babies were more often born by women who were overweight or obese before conception (p=0.0076), and those with gestational weight gains higher than recommended (p=0.0081). Mothers who gave birth to large-for-gestational age babies had higher values of haematological parameters in the first trimester of pregnancy, compared to the mothers of babies small for gestational age. No significant differences were found between the consumption of individual groups of products by mothers during pregnancy and birth weight of newborns. **Conclusions.** Significant differences in birth weight for gestational age were found according to the BMI of the mother before conception and total gestational weight gain in pregnancy. Among overweight or obese women who plan are planning reproduction, the normalization of body weight is recommended in order to decrease the risk of bearing a newborn with hypertrophy.
Key words:
birth weight, BMI before pregnancy, gestational weight gain, haematological parameters

Streszczenie
U osób urodzonych z małą masą ciała stwierdza się zwiększone ryzyko wystąpienia nadciśnienia tętniczego, dyslipidemii, chorób układu sercowo-naczyniowego, cukrzycy typu 2 w wieku dorosłym. U osób urodzonych z makrosomią również występuje zwiększone ryzyko późniejszego wystąpienia cukrzycy typu 2 i chorób sercowo-naczyniowych w wieku dorosłym. Bardzo ważne są więc badania służące zidentyfikowaniu czynników ryzyka zaburzeń wewnątrzmacicznego wzrastania płodu. **Cel pracy.** Celem pracy była ocena zależności między zachowaniami zdrowotnymi oraz wskaźnikami hematologicznymi kobiet ciężarnych a masą urodzeniową noworodków. **Materiał i metody.** Materiał badań stanowiły dane 274 kobiet i ich dzieci. Przy pomocy ankiety zebrano informacje na temat miejsca zamieszkania, wysokości i masy ciała, palenia papierosów oraz sposobu żywienia w czasie ciąży. Informacje dotyczące kolejności ciąży, przebiegu i czasu trwania ciąży oraz parametrów hematologicznych zebrano na podstawie analizy dokumentacji medycznej. **Wyniki.** Kobiety z niedowagą przed ciążą częściej rodziły dzieci z małą masą w stosunku do wieku płodowego, natomiast dzieci z dużą masą w stosunku do wieku płodowego częściej rodziły kobiety z nadwagą lub otyłością przed ciążą (p=0.0076) oraz te, u których stwierdzono w ciąży przyrost masy większy niż zalecany (p=0.0081). Matki, które urodziły dzieci z dużą masą w stosunku do wieku płodowego, częściej posiadały wyższe wartości wskaźników hematologicznych w pierwszym trymestrze ciąży w porównaniu z matkami dzieci o niższej masie w stosunku do wieku płodowego. Spożycie poszczególnych grup produktów przez matki w czasie ciąży nie różnicowało w istotny sposób masy urodzeniowej noworodków. **Wnioski.** Czynnikami istotnie różnicującymi wielkość urodzeniowej masy ciała

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w stosunku do wieku płodowego były BMI matki przed ciążą oraz całkowity przyrost masy w czasie ciąży. Wśród kobiet z nadwagą i otyłością planujących prokreację wskazana jest normalizacja masy ciała w celu zmniejszenia ryzyka urodzenia noworodka z hipertrofią.
Słowa kluczowe:
masa urodzeniowa, BMI przed ciążą, ciążowy przyrost masy, wskaźniki hematologiczne

Introduction

Health behaviours of women before conception and during pregnancy are among the most important factors which determine foetal growth and development [1–5]. The risk factors best documented in literature for giving birth to a baby small for gestational age (SGA) are underweight before pregnancy and low gestational weight gains [6,7]. The risk of bearing an SGA baby is also increased by the occurrence of anaemia in future mothers, cigarette smoking, and alcohol consumption [2,8–11]. In turn, a high consumption of milk and dairy products, fish and seafood, as well as vegetables and fruits by pregnant women, exerted a positive effect on birth weight [3–5, 12, 13]. The risk of giving birth to a baby large for gestational age (LGA) is related mainly to a high pre-pregnancy BMI and high gestational weight gains [6,7,14–16], high consumption of milk [17], a high percentage of energy supplied by sweets [18], and a high dietary glycaemic load in pregnant women [19].

In individuals born with a low birth weight, especially intrauterine foetal growth inhibition, an increased risk of occurrence of arterial hypertension, dyslipidemia, cardiovascular diseases, and type 2 diabetes is observed in adulthood. In individuals born with macrosomia, the risk of occurrence of type 2 diabetes and cardiovascular diseases is also noted in adulthood [20]. Therefore, studies aimed at the identification of risk factors of intrauterine foetal growth disorders are very important. Hence, the objective of the presented study was to evaluate the relationship between health behaviours and haematological parameters of pregnant women, and birth weight of newborns.

Material and methods

The materials for the study were the data concerning 274 women who, after giving birth were patients of the Clinic of Obstetrics and Gynaecology at the Regional Polyclinical Hospital in Kielce, and their babies. Women who delivered a healthy child (without congenital defects) were included in the study. Based on further analysis, 2 patients with twin pregnancy and 8 women whose data were incomplete were excluded. Information concerning pregnancy order, the course and duration of pregnancy, as well as haematological parameters were collected based on the analysis of medical records after obtaining patients' informed consent.

Using a questionnaire, information was collected pertaining to the place of residence, age, body height and weight, cigarette smoking, and the eating habits during pregnancy. The questions in the survey related to the number of portions of individual groups of food products consumed. The size of food portions was determined in accordance with the principles presented in the relevant literature [20]. The nutritional status prior to pregnancy was assessed based on the declared data concerning body height and weight, which served to calculate the BMI, and groups of patients distinguished with: underweight (BMI <18.5 kg/m^2), normal body weight (18.5–24.9 kg/m^2), overweight or obesity (BMI ≥ 25.0 kg/m^2). The total body weight gain during pregnancy was calculated as a difference between perinatal weight and pre-pregnancy body weight. Gestational weight gains were classified as low, recommended, or high, according to the guidelines by the Institute of Medicine (IOM) and National Academy of Sciences (NAS) in the USA [6]. Haematological parameters of mothers considered in the study covered the erythrocyte count (mln/mm^3), haemoglobin concentration (g/dl) and haematocrit (%). For the analysis, data from the first examination performed by the patient after conception was used, examinations performed in the middle of the second trimester of pregnancy and the last examination performed before delivery. As the diagnostic criteria for anaemia in the women in the study, the level of haemoglobin <11.0 g/dl in the first and third trimester of pregnancy and <10.5 g/dl during the second trimester, were adopted, according to the recommendations by the WHO and the Centres for Disease Control [21]. Birth weight of newborns was referred to the standards with consideration of gender and gestational age [22]. On this basis, babies small-for-gestational age – SGA ($<$ 10 centile), were distinguished, those appropriate-for-gestational age – AGA (10–90 centile), and large-for-gestational age – LGA ($>$ 90 centile). Statistical analysis was performed using the Statistica 6.0 (StatSoft) software. The relationship between socio-demographic factors and health behaviours of mothers and birth weight of newborns were evaluated using chi-square test ($\chi 2$) of the highest reliability (table I–IV). While for the evaluation of the relationships between haematological parameters of mothers and birth weight of newborns, one-way analysis of variance was applied (table VI), and *post hoc* NIR test (least significant differences). The p values $p<0.05$ were considered statistically significant.

Results

Table I presents the general characteristics of the babies examined and their mothers. More than 11% of babies were large for gestational age, while only 6.1% – small for gestational age. In nearly 92% of newborns the result of the score according to the Apgar scale in the first minute after birth remained within the range of 8–10 scores. Overweight and obesity before pregnancy occurred in 19.5% of the women examined. A low total gestational weight gain was observed in 5.6% patients, whereas gain higher than recommended in 8.8%. Nearly every tenth woman reported cigarette smoking in pregnancy, and

Table I. General characteristics of the babies and their mothers examined
Tabela I. *Ogólna charakterystyka badanych noworodków i ich matek*

Factors / *Czynniki*		N	%
Gender of the newborns / *Płeć noworodków*	Boys / *chłopcy*	131	49.6
	Girls / *dziewczynki*	133	50.4
Birth weight for gestational age / *Masa urodzeniowa w stosunku do wieku płodowego*	SGA[1]	16	6.1
	AGA[2]	218	82.5
	LGA[3]	30	11.4
Apgar scores / *Wynik w skali Apgar*	8 - 10	237	91.9
	≤ 7	21	8.1
Place of residence *Miejsce zamieszkania*	town / *miasto*	137	51.9
	village / *wieś*	127	48.1
Age of the mother / *Wiek matki*	< 30 years / *< 30 lat*	153	57.9
	≥ 30 years / *≥ 30 lat*	111	42.1
Order of birth / *Kolejność porodu*	first / *pierwszy*	115	48.7
	second / *drugi*	95	40.3
	third or subsequent / *trzeci lub kolejny*	26	11.0
BMI before pregnancy / *BMI przed ciążą*	< 18.5	19	7.6
	18.5-24.9	183	72.9
	≥ 25.0	49	19.5
Gestational weight gain / *Ciążowy przyrost masy ciała*	low / *niski*	12	5.6
	recommended / *zalecany*	185	85.6
	high / *wysoki*	19	8.8
Cigarette smoking during pregnancy / *Palenie papierosów w ciąży*	no / *nie*	181	69.6
	exposed / *narażone*	54	20.8
	yes / *tak*	25	9.6
Drinking of alcohol during pregnancy / *Picie alkoholu w ciąży*	no / *nie*	212	80.3
	yes / *tak*	52	19.7

[1]Small-for-gestational age / *mała masa w stosunku do wieku płodowego*; [2]Appropriate-for-gestational age / *prawidłowa masa w stosunku do wieku płodowego*; [3]large-for-gestational age / *duża masa w stosunku do wieku płodowego*; applies to tables I–VII.

every fifth was exposed to tobacco smoke in the nearest environment. Also, every fifth woman consumed alcoholic beverages during pregnancy.

No significant differences were found in the occurrence of SGA and LGA newborns according to gender, also there were no significant differences in the Apgar rating according to the birth weight category (data not shown). Birth weight for gestational age significantly differed according to the BMI of the mother before conception and total gestational weight gain in pregnancy (table II). Patients who were underweight before pregnancy more frequently gave birth to SGA babies, whereas those overweight and obese – LGA babies. Similarly, babies large for gestational age were more often born by mothers with gestational weight gain higher than recommended. No significant differences were observed between birth weight and place of residence, age of the mother, and pregnancy order. A tendency was only noted towards more frequent occurrence of low birth weight in the urban environment and first-born children. Also, no significant differences were found between smoking and exposure to tobacco smoke and birth weight. However, a slightly more frequent occurrence of low birth weight could be observed with respect to gestational age in babies of mothers who smoked and women exposed to tobacco smoke, compared to non-smokers.

No significant differences were found between the consumption of individual groups of products by mothers during pregnancy and birth weight of newborns (table III). Nevertheless, a tendency was noted towards the consumption of a smaller amount of fruit, vegetables, milk and dairy products, and a less frequent snacking between meals by mothers of children with low weight, compared to those who delivered babies with appropriate and high weight. Also, no differences were noted between the frequency of consumption of selected beverages by mothers during pregnancy and birth weight (table IV). No relationships were found between the consumption of folic acid and other dietary vitamin and/or mineral supplements in pregnancy, and birth weight of newborns (table V).

Anaemia was diagnosed in 1.9% of the total number of women in the first trimester, 2.9% in the second, and 7.5% in the third trimester of pregnancy. However, it is noteworthy that the examined levels of haemoglobin in the first trimester were examined in only 80.7% of the women enrolled for further

Table II. Birth weight for gestational age according to selected characteristics (%)
Tabela II. *Urodzeniowa masa ciała w stosunku do wieku płodowego w zależności od wybranych czynników (%)*

Factors / *Czynniki*		Birth weight / Urodzeniowa masa ciała		
		SGA	AGA	LGA
BMI before pregnancy / *BMI przed ciążą* **p=0.0076**	< 18.5	20.0	6.8	6.7
	18.5 – 24.9	73.3	76.2	50.0
	≥ 25.0	6.7	17.0	43.3
Gestational weight gain / *Ciążowy przyrost masy ciała* **p=0.0081**	low / niski	41.7	22.7	15.8
	recommended / *zalecany*	41.7	38.9	10.5
	high / *wysoki*	16.6	38.4	73.7
Order of birth / *Kolejność porodu* p=0.0972	first / *pierwszy*	61.5	47.5	51.9
	second / *drugi*	30.8	39.8	48.1
	third or subsequent / *trzeci lub kolejny*	7.7	12.8	0.0
Age of the mother / *Wiek matki* p=0.8130	<30 years / *<30 lat*	56.3	57.3	63.3
	≥30 years / *≥30 lat*	43.8	42.7	36.7
Place of residence / *Miejsce zamieszkania* p= 0.2553	town / *miasto*	68.7	51.4	46.7
	village / *wieś*	31.3	48.6	53.3
Cigarette smoking during pregnancy / *Palenie papierosów w ciąży* p=0.8932	no / *nie*	60.0	70.2	70.0
	exposed / *narażone*	26.7	20.0	23.3
	yes / *tak*	13.3	9.8	6.7

Table III. Frequency of consumption of selected products during pregnancy and birth weight (%)
Tabela III. *Częstość spożycia wybranych produktów w czasie ciąży a urodzeniowa masa ciała (%)*

Products and meals / *Produkty i posiłki*	Amount of servings consumed / *Ilość spożywanych porcji*	Birth weight / *Urodzeniowa masa ciała*		
		SGA	AGA	LGA
Fruit / *Owoce* p=0.3442	<1 daily / *<1 dziennie*	18.8	11.0	3.3
	1-2 daily / *1–2 dziennie*	43.8	55.1	50.0
	≥3 daily / *≥3 dziennie*	37.5	33.9	46.7
Vegetables / *Warzywa* p=0.5067	<1 daily / *<1 dziennie*	25.0	19.3	16.6
	1-2 daily / *1–2 dziennie*	62.5	52.3	46.7
	≥3 daily / *≥3 dziennie*	12.5	28.4	36.7
Milk and dairy products / *Mleko i przetwory mleczne* p=0.7118	<1 daily / *<1 dziennie*	31.3	22.0	20.0
	1-2 daily / *1-2 dziennie*	43.7	58.7	53.3
	≥3 daily / *≥3 dziennie*	25.0	19.3	26.7
Animal protein / *Białko zwierzęce* p=0.5206	<1 daily / *<1 dziennie*	6.3	20.7	23.3
	1-2 daily / *1–2 dziennie*	75.0	58.1	53.3
	≥3 daily / *≥3 dziennie*	18.7	21.2	23.3
Sea fish / *Ryby morskie* p=0.9078	never / *wcale*	18.8	14.2	20.0
	<1 in a week / *<1 w tygodniu*	50.0	47.7	43.3
	≥1 in a week / *≥1 w tygodniu*	31.2	38.1	36.7
Confectionery and sweets / *Produkty cukiernicze i słodycze* p=0.6366	≤3 in a week / *≤3 w tygodniu*	56.3	47.2	60.0
	4-7 in a week / *4-7 w tygodniu*	18.8	29.4	23.3
	>1 daily / *>1 dziennie*	25.0	23.4	16.8
Number of meals / *Liczba posiłków* p=0.9242	≤3	18.8	12.8	16.7
	4	31.2	33.9	36.7
	≥5	50.0	53.2	46.7
Snacking between meals / *Pojadanie między posiłkami* p=0.4181	< once a day / *<1 raz dziennie*	56.3	33.6	36.7
	once a day / *1 raz dziennie*	18.7	38.3	33.3
	> once a day / *>1 raz dziennie*	25.0	28.1	30.0

analysis; therefore, the percentage of patients with anaemia might have been slightly higher. No differences were found between the occurrence of anaemia in mothers and birth weight (table VI). It was noted that in the 1st and 2nd trimester anaemia did not occur in any of the mothers who gave birth to a baby large for gestational age. Analysis of the mean haematological parameters in pregnant women showed a tendency towards the highest level of erythrocytes, haemoglobin, and haematocrit in mothers who gave birth to LGA babies (table VII). These differences were most clearly observed in the first trimester of pregnancy, and in the case of haematocrit were statistically significant. The results of *post hoc* test also confirmed that considering both haematocrit and haemoglobin levels, mothers who gave birth to LGA babies had significantly higher values of haematological parameters, compared to the mothers of the remaining babies.

Table IV. Frequency of consumption of selected beverages in pregnancy and birth weight (%)
Tabela IV. *Częstość spożycia wybranych napojów w czasie ciąży a urodzeniowa masa ciała (%)*

Beverages / *Napoje*	Amount of servings consumed / *Ilość spożywanych porcji*	Birth weight / *Urodzeniowa masa ciała*		
		SGA	AGA	LGA
Sweetened carbonated drinks / *Słodzone napoje gazowane* p=0.8651	never / *wcale*	37.5	35.8	26.7
	≤3 cups a week / *≤3 szklanki w tygodniu*	37.5	41.3	50.0
	≥4 cups a week / *≥4 szklanek w tygodniu*	25.0	22.9	23.3
Fruit juices / *Soki owocowe* p=0.4276	<1 cup a week or never / *<1 szklanka w tygodniu lub wcale*	25.0	19.4	13.3
	1-6 cups a week / *1-6 szklanek w tygodniu*	25.0	45.2	53.3
	≥1 cups a day / *≥1 szklanka dziennie*	50.0	35.5	33.3
Milk / *Mleko* p=0.6320	<1 cup a week or never / *<1 szklanka w tygodniu lub wcale*	37.6	30.9	43.3
	1-6 cups a week / *1-6 szklanek w tygodniu*	31.2	42.4	36.7
	≥1 cups a day / *≥1 szklanka dziennie*	31.2	26.7	20.0
Alcohol / *Alkohol* p=0.8628	no / *nie*	75.0	80.7	80.0
	yes / *tak*	25.0	19.3	20.0

Table V. Consumption of folic acid and other dietary supplements and birth weight (%)
Tabela V. *Przyjmowanie kwasu foliowego i innych suplementów a urodzeniowa masa ciała (%)*

Consumption of supplements / *Przyjmowanie suplementów*		Birth weight / *Urodzeniowa masa ciała*		
		SGA	AGA	LGA
Folic acid / *kwas foliowy* p = 0.5643	yes / *tak*	93.7	91.7	96.7
	no / *nie*	6.3	8.3	3.3
Beginning of the consumption of folic acid / *początek przyjmowania kwasu foliowego* p = 0.1291	before pregnancy / *przed ciążą*	26.7	40.5	20.7
	1st-12th weeks of pregnancy / *1-12 tydzień ciąży*	60.0	53.0	75.9
	after the 12th week of pregnancy / *po 12 tygodniu ciąży*	13.3	6.5	3.4
Other supplements / *inne suplementy* p = 0.2971	yes / *tak*	37.5	25.0	16.7
	no / *nie*	62.5	75.0	83.3

Table VI. Occurrence of anaemia in mothers and birth weight of newborns (%)
Tabela VI. *Występowanie niedokrwistości u matek a wielkość masy urodzeniowej noworodków (%)*

Trimester of pregnancy / *Trymestr ciąży*	Hemoglobin concentration / *Stężenie hemoglobiny [g/dl]*	Birth weight / *Urodzeniowa masa ciała*		
		SGA	AGA	LGA
I	≥ 11.0	100.0	97.7	100.0
p=0.4115	< 11.0	0.0	2.3	0.0
II	≥ 10.5	93.3	96.9	100.0
p=0.3287	< 10.5	6.7	3.1	0.0
III	≥ 11.0	76.9	93.6	92.3
p=0.1816	< 11.0	23.1	6.4	7.7

Table VII. Haematological parameters of mothers and birth weight of newborns [X±SD]
Tabela VII. *Wskaźniki hematologiczne matek a masa urodzeniowa noworodków* [*X*±*SD*]

T*	Haematological parameters of mothers / *Wskaźniki hematologiczne matek*	Birth weight / *Urodzeniowa masa ciała*			F	p
		SGA	AGA	LGA		
I	RBC** [mln/mm^3]	4.18±0.32	4.34±0.39	4.47±0.35	2.73	0.068
	haemoglobin / hemoglobina [g/dl]	12.7±0.67	12.9±0.95	13.3±0.98	2.97	0.053
	haematocrit / hematokryt [%]	37.8±3.25	37.7±2.56	39.1±2.69	**3.22**	**0.042**
II	RBC** [mln/mm^3]	3.87±0.44	3.93±0.28	3.96±0.45	0.41	0.665
	haemoglobin / hemoglobina [g/dl]	11.9±0.82	11.9±0.79	12.1±0.93	0.42	0.657
	haematocrit / hematokryt [%]	33.6±6.45	35.4±2.46	35.8±2.78	2.94	0.055
III	RBC** [mln/mm^3]	3.85±0.39	3.97±0.32	4.01±0.37	0.93	0.397
	haemoglobin / hemoglobina [g/dl]	12.0±1.25	12.0±0.76	12.1±0.89	0.02	0.982
	haematocrit / hematokryt [%]	35.7±3.59	35.7±2.50	36.3±2.27	0.61	0.544

* Trimester of pregnancy / trymestr ciąży
** Erythrocyte count / liczba erytrocytów

Discussion

The results of the study showed that women who were underweight before pregnancy were more likely to give birth to SGA babies, whereas LGA babies were more often born by women who were overweight or obese before conception, and those with gestational weight gains higher than recommended. These relationships are entirely in accordance with the results obtained by other researchers [6,7,14–16].

There were no significant differences between the frequency of consumption by mothers of individual groups of products in pregnancy and birth weight of newborns. The lack of significant differences between the diet of mothers and birth weight was also found by Poon et al. [14]. However, a clear tendency was observed towards the consumption of a smaller amount of fruits, vegetables, milk and dairy products, and less frequent snacking between meals by mothers of SGA babies, compared to mothers of AGA and LGA chil-

dren. This tendency, consistent with the relationships noted in many studies, indicates that it is necessary to carry out further studies which would cover a larger number of pregnant women [1,3–5,12,13]. A tendency was also noted towards the more frequent occurrence of low birth weight in babies of mothers who smoked and those exposed to tobacco smoke, compared to non-smokers, which is also in accordance with the results by other researchers [10]. Data from literature concerning the relationship between alcohol consumption in pregnancy and the risk of giving birth to SGA baby are incoherent. One of the studies showed that the risk of SGA was OR=1.7 in the case of consumption in the 1st trimester <2 units alcohol/daily (1 unit = 10 mL pure alcohol), and OR=2.0 in the case of consumption of >2 units/week, compared to teetotallers [11]. However, meta-analysis published in 2011 indicated that low or moderate consumption of alcohol (up to 10 g/daily) did not increase the risk of SGA, and such risk occurred only in the case of heavy alcohol consumption [23]. Thus, the lack of relationship between the consumption of alcoholic beverages by the pregnant women in the study and birth weight of their children may indicate a relatively low consumption of alcohol in this group.

The percentage of women with anaemia among the examined women was low, and close to the percentage of pregnant women with anaemia found in a study conducted in Finland [24]. No differences were observed between the occurrence of anaemia in mothers and birth weight of newborns. Nevertheless, a clear tendency was noted towards higher values of haematological parameters in the first trimester of pregnancy in mothers who gave birth to LGA babies, compared to the babies of the remaining mothers. The results of the majority of studies indicate that the occurrence of anaemia in future mothers is related to a higher risk of bearing a SGA baby [8,9,25]. Haider et al. calculated that birth weight of newborns increased by 14.0 g (6.8 – 21.8 g), together with an increase in the level of haemoglobin, each by 1 g/L [9]. Also, Demmouche et al. did not find any statistically significant difference between groups with various haemoglobin levels according to the mean birth weight [26]. Räisänen et al. observed that anaemia was related to the risk of SGA, but only in multiparous women [24].

Conclusion

Significant differences were observed between birth weight of newborns and the indices of nutritional status of pregnant women. LGA babies were more frequently born by mothers who were overweight or obese before pregnancy, and those with total gestational weight gain higher than recommended, while SGA babies were more often born by women who were underweight before conception.

Mothers who gave birth to LGA babies had higher values of haematological parameters in the first trimester of pregnancy, compared to the mothers of babies small for gestational age.

Among overweight or obese women who plan reproduction, the normalization of body weight is recommended in order to decrease the risk of bearing a newborn with hypertrophy.

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References

1. Rodríguez-Bernal C.L., Rebagliato M., Iñiguez C. et al.: *Diet quality in early pregnancy and its effects on fetal growth outcomes: the Infancia y Medio Ambiente (Childhood and Environment) Mother and Child Cohort Study in Spain.* Am. J. Clin. Nutr., 2010: 91, 1659-1666.
2. Alwan N., Greenwood D.C., Nigel A.B. et al.: *Dietary iron intake during early pregnancy and birth outcomes in a cohort of British women.* Hum. Reprod., 2011:26, 911-919.
3. Brantsæter A.L., Olafsdottir A.S., Forsum E. et al.: *Does milk and dairy consumption during pregnancy influence fetal growth and infant birth weight? A systematic literature review.* Food Nutr Res., 2012:56, 20050.
4. Brantsæter A.L., Birgisdottir B.E., Meltzeret H.M. 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, 436-444.
5. Borazjani F., Angali K.A., Shanuak S. et al.: *Milk and protein intake by pregnant women affects growth of foetus.* J. Health Popul. Nutr., 2013:31, 435-445.
6. Rasmussen K.M., Yaktine A.L. (eds).: *Weight gain during pregnancy: reexamining the guidelines.* Washington D.C.: Institute of Medicine, National Research Council of the National Academies, 2009.
7. Drehmer M., Duncan B.B., Kac G., Schmidt M.I.: *Association of second and third trimester weight gain in pregnancy with maternal and fetal outcomes.* PLoS One, 2013:8, e54704.
8. Cogswell M.E., Parvanta I., Ickes L. et al.: *Iron supplementation during pregnancy, anemia, and birth weight: a randomized controlled trial.* Am. J. Clin. Nutr., 2003:78, 773-781.
9. Heider B.A., Olofin I., Wang M. et al.: *Anaemia, prenatal iron use, and risk of adverse pregnancy outcomes: systematic review and meta-analysis.* BMJ, 2013:346, 3443.
10. Baba S., Wikström A.-K., Stephansson O., Cnattingius S.: *Changes in snuff and smoking habits in Swedish pregnant women and risk for small-for-gestational-age births.* BJOG, 2013:120, 456-462.
11. Nykjaer C., Alwan N.A., Greenwood D.C. 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, 542-549.

12. 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, 774-783.
13. Murphy M.M., Stettler N., Smith K.M. 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.
14. Poon A.K., Yeung E., Boghossian N. et al.: *Maternal dietary patterns during third trimester in association with birthweight characteristics and early infant growth.* Scientifica (Cairo), 2013:2013, 786409.
15. 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.
16. Haugen M., Brantsæter A.L., 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.
17. Olsen S.F., Halldorsson T.I., Willett W.C. et al.: *Milk consumption during pregnancy is associated with increased infant size at birth: prospective cohort study.* Am. J. Clin. Nutr., 2007:86, 1104-1110.
18. Phelan S., Hart C., Phipps M. et al.: *Maternal behaviors during pregnancy impact offspring obesity risk.* Exp. Diabet. Res., 2011:2011, 985139.
19. Knudsen V.K., Heitmann B.L., Halldorsson T.I. 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.
20. Szostak-Węgierek D., Szamotulska K.: *Fetal development and risk of cardiovascular diseases and diabetes type 2 in adult life.* Dev. Per. Med., 2011:15, 203-215.
21. Walsh T., O'Broin S.D., Cooley S. et al.: *Laboratory assessment of iron status in pregnancy.* Clin. Chem. Lab. Med., 2011:49, 1225-1230.
22. Fenton T.R., Kim J.H.: *A systematic review and meta-analysis to revise the Fenton growth chart for preterm infants.* BMC Pediatrics., 2013:13, 59.
23. 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(12), 1411-1421.
24. Räisänen S., Kancherla V., Gissler M. et al.: *Adverse perinatal outcomes associated with moderate or severe maternal anaemia based on parity in Finland during 2006-10.* Paediatr. Perinatal. Epidemiol., 2014:28(5), 372-380.
25. Sukrat B., Wilasrusmee C., Siribumrungwong B. et al.: *Hemoglobin concentration and pregnancy outcomes: a systematic review and meta-analysis.* Biomed. Res. Int., 2013:2013, 769057.
26. Demmouche A., Lazrag A., Moulesshoul S.: *Prevalence of anaemia in pregnant women during the last trimester: consequence for birth weight.* Eur. Rev. Med. Pharmacol Sci., 2011:15(4), 436-445.

