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Serum leptin levels in pregnant women and umbilical cord: relationship to mother and neonate anthropometry

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Pregnancy is the period in a woman's life when during a short time the her body weight increases apace with the synthesis of new tissues and changes in metabolism chain. The aim of this study was to examine leptin concentrations in maternal and umbilical cord serum in relationship to maternal and neonate anthropometry.

Paitiens and methods. We measured serum leptin levels in 112 pregnant women at 7–38 weeks of pregnancy and cord serum leptin levels in 30 neonates by specific RIA methods.

The bioelectric impedance method was employed to measure the body fat of 112 pregnant women. Their BMI was calculated (kg/m^2). Thirty neonates were measured after delivery. The data were processed by statistical analysis. Their statistical reliability was provided.

Results. Total leptin levels rise from the beginning of pregnancy till the beginning of the 3rd trimester (22.24 ± 1.8 ng/ml to 37.29 ± 1.93 ng/ml).

Maternal BMI and adipose tissue significantly increased during 16–28 weeks of gestation and later ($p < 0.0001$). There was a significant ($p < < 0.0001$) correlation between maternal BMI, adipose tissue and serum leptin concentration (ng/ml).

The average body length of neonates was 54.0 ± 0.4 cm. The average weight of neonates was 3517.2 ± 72.4 g. The average cord leptin concentration was 3.2 ng/ml. There was a reliable correlation ($p < 0.005$) between body weight and cord leptin concentration. However, only a tendency of a correlation was found between body length and cord leptin concentration.

Conclusions. Significant associations were found between maternal leptin and BMI, adipose tissue in pregnancy, and between cord leptin at delivery and birthweight, as well as among other anthropometrical markers of fetal growth.

Key words: leptin, pregnancy, BMI, adipose tissue

INTRODUCTION

Anthropometric alterations in a pregnant women as well as the physical development of the fetus pose an important problem in obstetrics. The fetal growth and development are affected by many endogenous and exogenous factors (1, 2). The evaluation of their impact on a pregnant woman and a fetus, measurement of the degree of influence on maternal and fetal health forms a significant field of modern prenatal medicine and scientific research in obstetrics. Various demographic, maternal anthropometrical and metabolic factors have been correlated with fetal growth (3, 4).

Worldwide, more and more studies are carried out with the aim to measure and evaluate the influence of various factors affecting the anthropometrical alterations and physical development of the fetus.

While examining a correlation of the factors that determine fetal growth, it is necessary to find the degree of influence (maternal and fetal) of each factor separately and of their groups.

Volatile living conditions, various social-economic changes of life, climate, ethnical, ecological and other factors seem to make the correction of the rapport between the mother and the fetus. Therefore the specificity of a country is highly significant.

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When examining the peculiarities of fetal growth, it is necessary to analyze not only fetal factors, but also morphofunctional maternal characteristics, which become an essential scientific object (5).

In Lithuania, over the recent 15 years the moral, social and economic changes have influenced not only the morbidity of various population groups, but also the health of pregnant women as well as factors of fetal growth and physical development.

Morbidity of pregnant women, decreasing birthrate, and vital statistics of Lithuania obligate doctors-obstetricians-gynaecologists to examine and evaluate the influence of new factors on pregnancy. This issue has not only medical but also social and economic aspects.

Therefore, a correlation between leptin hormone and the above-mentioned factors was elucidated while examining anthropometrical changes during pregnancy and the physical growth of a fetus.

Leptin is a protein encoded by the ob gene (obese gene) and secreted in proportion to adipocyte size and number (6). The hormone has a molecular weight of 16 kDa, and it probably executes its effects by binding to receptors found in the hypothalamus and other tissues (7, 8). Leptin participates in many human physiological processes (9). The circulating leptin concentrations positively correlate with the body mass index and better with the percentage of body fat (10, 11). The rate of leptin production depends on gender, BMI, food intake, hormones, and other factors (12).

Alterations in leptin concentrations were observed to increase with the time period of pregnancy, when anthropometrical and metabolic alterations take place.

Leptin can be found also in the cord blood. Supposedly it comes into the cord from the fetus and placenta. It is highly important for metabolism and fetal development (13).

The goal of this study was to examine leptin concentration in maternal and cord serum and its relationship to maternal anthropometry and fetal growth.

The anthropometrical analysis of the pregnant women had already been carried out at Vilnius University, so it was the follow-up of the available scientific data, providing a possibility to evaluate the tendencies of interrelation among the factors.

PATIENTS AND METHODS

One hundred and twelve pregnant women were recruited from Vilnius Maternity Hospital. The women were healthy, between 19 and 38 years of age, and primipara or multipara. The participants signed a written consent, and the study was approved by local ethics committee. The study was prospected.

Blood samples were taken from mothers 2 or 3 times during pregnancy (at weeks 7 to 38 of gestation). The samples were collected between 8 AM and 10 AM, nonfasting. Blood samples were taken also from the umbilical cord at delivery. Leptin was measured in serum by a specific radio immunoassay method, using recombinant ^{125}I-leptin as a tracer (14).

The BMI values of the women were calculated using BMI = weight (kg)/height (m^2) within pregnancy. The body fat percentage – absolute and relative amount of adipose tissue – was measured with a body fat monitor (Omron BF 302). It works according to the BIA (bioelectrical impedanse analysis) method and analyses the electric resistance of body tissues by sending an extremely weak electrical current through the body (15).

Thirty healthy newborns were routinely weighed and measured in the delivery room. The data are expressed as an arithmetic mean (M) with a standard deviation (MSD) and correlation-statistical analysis. Statistical reability is provided.

RESULTS

On examining blood serum leptin levels in 112 pregnant women (Table 1), the reliability ($p < 0.003$) increased from 27.24 ± 1.8 ng/ml (≤15 weeks of gestation) to 37.29 ± 1.93 ng/ml (16–23 weeks of gestation) Starting from week 29 of gestation, leptin concentrations had a tendency to decrease ($p < 0.1$).

During the whole period of gestation the maternal body mass index gradually increased (Table 2). The most significant and reliable alterations ($p < 0.001$) of maternal BMI were observed in weeks 16–28 of gestation and later ($p < 0.0001$).

Table 1. **Blood-serum leptin (ng/ml) concentrations during human pregnancy**

Gestation period	Number of pregnants	Leptin concentration (ng/ml)		
(weeks)	(N)	M ± m(M)	Min	Max
≤ 15	41	27.24 ± 1.80	5.30	52.0
16–28	47	37.29 ± 1.93	10.30	70.20
≥ 29	24	31.74 ± 2.86	6.0	63.50

Table 2. **Maternal BMI dynamics**

Gestation period	Number of pregnants	BMI		
(weeks)	(N)	M ± m (M)	Min	Max
≤ 15	41	22.34 ± 0.56	17.96	36.06
16–28	50	25.16 ± 0.56	18.66	37.92
≥ 29	24	26.17 ± 0.72	20.73	35.34

The body fat percentage (kg) increased during the whole pregnancy (Table 3), with the peak at 16 to 28 weeks of gestation. In this period ($p < 0.002$) and after 29 weeks of gestation, the fat mass was considerably higher than in the early stage of pregnancy, *i.e.* till week 15 of gestation.

While measuring relative (%) alterations of a pregnant body (Table 4), it was found that maternal body fat percentage increased especially at 16 to 28 weeks of gestation ($p < 0.006$); at week 29 and later the adipose tissue increase was considerably ($p < 0.001$) higher than till week 15 of gestation.

Table 3. **Maternal adipose tissue content (kg)**

Gestation period	Number of pregnants	Adipose tissue content (kg)		
(weeks)	(N)	M ± m (M)	Min	Max
≤ 15	41	16.75 ± 1.05	7.3	38.6
16–28	49	21.69 ± 1.13	10.1	42.3
≥ 29	24	23.55 ± 1.42	13.3	41.8

Table 4. **Maternal adipose tissue content (%)**

Gestation period	Number of pregnants	Adipose tissue content (%)		
(weeks)	(N)	M ± m(M)	Min	Max
≤ 15	41	25.98 ± 0.91	14.8	41.1
16–28	49	29.49 ± 0.84	18.3	43.2
≥ 29	24	30.77 ± 0.94	22.0	40.2

There was a positive and confident ($p < 0.0001$) correlation (Figs. 1–3) between maternal BMI, body fat percentage and blood serum leptin concentrations. These indices correlate in both absolute and relative proportions.

The average length of the neonates was 54.0 ± ± 0.4 cm. The height of the smallest neonate was

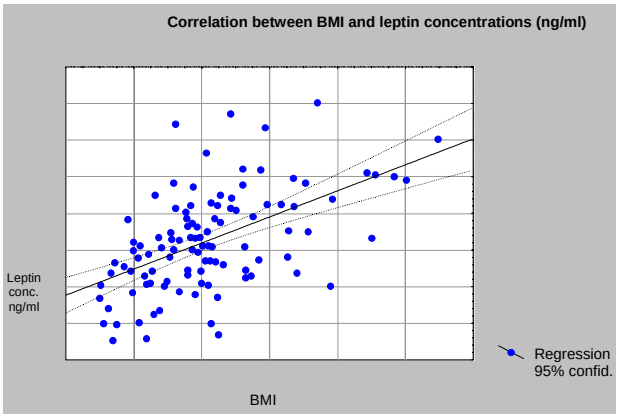


Fig. 1. Correlation between body mass index and leptin concentrations (ng/ml)

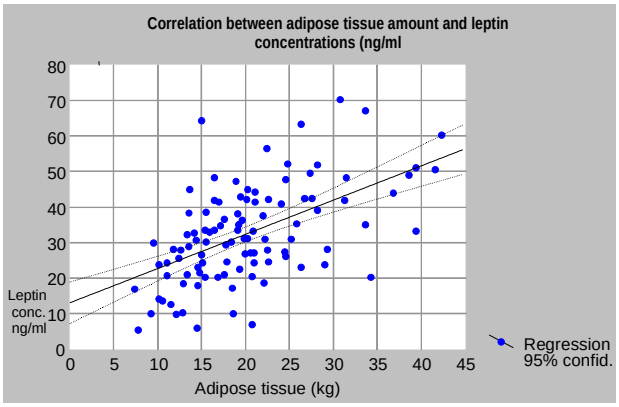


Fig. 2. Correlation between adipose tissue amount (kg) and leptin concentrations (ng/ml)

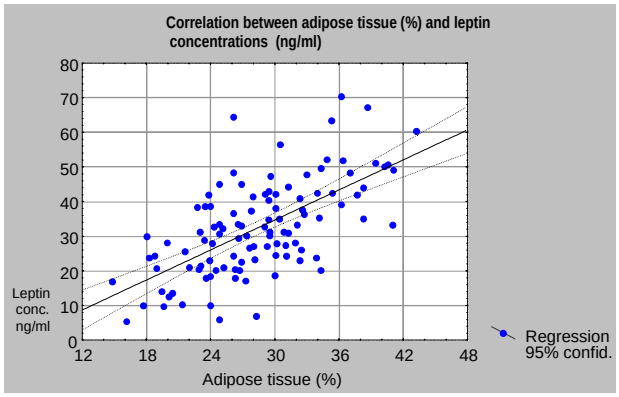
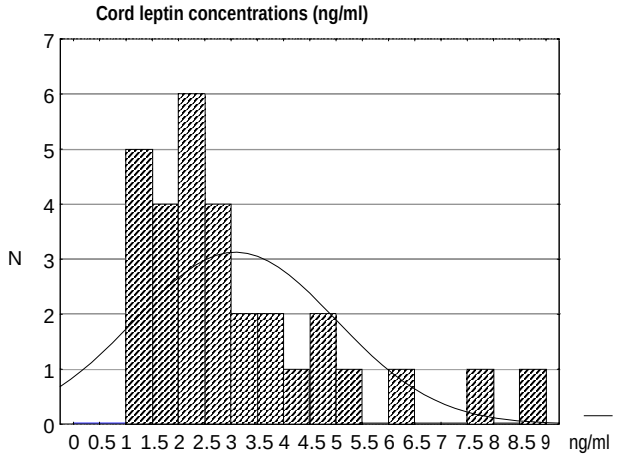


Fig. 3. Correlation between adipose tissue amount (%) and leptin concentrations

Table 5. **Lenght (cm) and weight (g) of neonates**

	Number of neonates (N)	M ± m (M)	Min	Max
Length (cm)	30	54.0 ± 0.4	45	62
Weight (g)	30	3517.2 ± 72.4	960	4660



***N – number of neonates**
***M – averge cord concentration was 3.2 ng/ml**
***Max – the highest concentration was 8.8 ng/ml**

Fig. 4. Cord leptin concentrations (ng/ml)

45 cm and of the biggest 62 cm. The average weight of the neonates was 3517.2 ±.72.4 g (Table 5).

The average cord leptin concentration was 3.2 ng/ml and the highest 8.8 ng/ml (Figure 4).

A reliable ($p < 0.005$) and on the average strong correlation (Fig. 5) between weight and fetal cord leptin concentrations (ng/ml) of 30 examined neonates was found. However, only a tendency of correlation between length (cm) and fetal cord leptin concentrations (ng/ml) was found (Fig. 6).

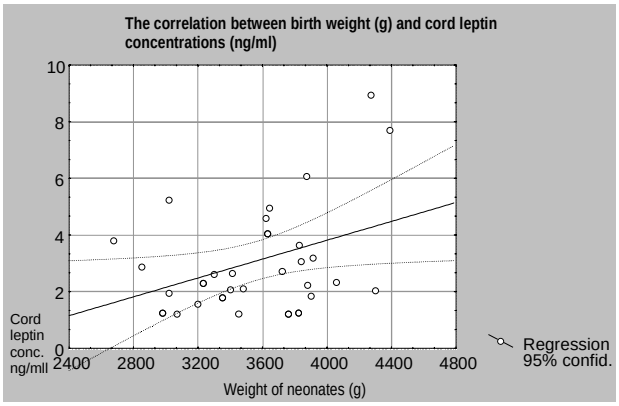


Fig. 5. Correlation between birth weight (g) and leptin concentrations

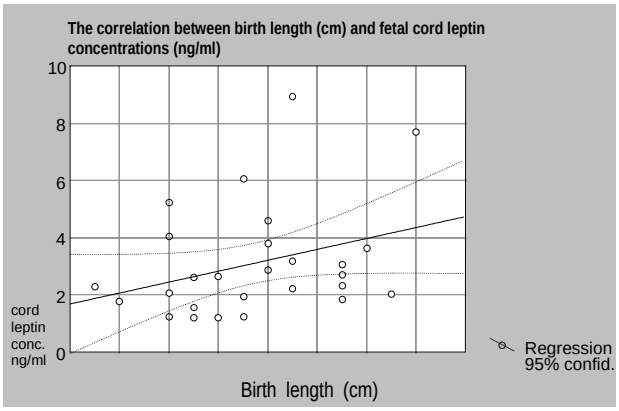


Fig. 6. The correlation between birth length (cm) and cord leptin concentrations (ng/ml)

DISCUSSION

The maternal BMI and adipose tissue increase during pregnancy. The enhanced BMI and adipose tissue reflect the growing fetus and uterus, an increase of blood volume and fat depots. The changes of pregnancy and maternal adaptations to these signals are extraordinary. These changes are necessary for modification of maternal homeostasis to provide nutritional support for the developing fetus and preparation for lactation following delivery. The maternal serum leptin level rises from the beginning of pregnancy till the beginning of the 3rd trimester (22.24 ± 1.8 ng/ml to 37.29 ± 1.93 ng/ml), and starting from week 29 of gestation leptin concentrations have a tendency to decrease to 31.74 ± ± 2.86 ng/ml ($p < 0.1$). This finding supports the hypotesis that the maternal serum leptin level increases during the rapid fetal growth and development.

Besides, the increase in serum leptin concentration during pregnancy might atribute to the transfer of placental leptin to maternal circulation.

We observed a confident ($p < 0.005$) and strong correlation between birthweight and cord leptin concentrations (ng/ml) in 30 neonates. However, only a tendency of a correlation between body length and cord leptin concentrations was found, possibly because of a high expression of the ob gene in brown adipose tissue.

In conclusion, we found significant associations between maternal leptin and BMI, adipose tissue in pregnancy, and between cord leptin at delivery and birthweight, as well as among other anthropometric markers of fetal growth.

CONCLUSIONS

Our study showed that maternal blood serum leptin concentrations increased from the beginning of pregnancy till the beginning of the 3rd gestational trimester and started to decrease at the approach of birth term. There was a confident and direct correlation between maternal BMI, adipose tissue and serum leptin concentrations.

Also, a reliable correlation was found between fetal cord blood leptin levels and birth weight.

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NĖŠČIŲJŲ KRAUJO SERUMO IR VIRKŠTELĖS KRAUJO SERUMO LEPTINO KIEKIO RYŠYS SU MOTINOS IR NAUJAGIMIŲ ANTROPOMETRIJA

S a n t r a u k a

Įvadas. Nėštumas – moters gyvenimo tarpsnis, kai per trumpą laiką sparčiai auga nėščiosios svoris, vyksta naujų audinių sintezė, hormoniniai bei medžiagų apykaitos grandžių pakitimai.

Mūsų darbo tiklas buvo ištirti leptino pokyčius nėštumo metu, jų ryšį su nėščiųjų kūno masės indeksu (KMI) ir pasyviosios kūno masės kiekiu, įvertinti naujagimio fizinio išsivystymo bei virkštelės kraujo serumo leptino kiekio ryšį.

Medžiaga ir tyrimo metodai. Radioimuniniu metodu nustatytas 112 sveikų nėščiųjų (7–38 nėštumo savaitę) kraujo serumo ir 30 naujagimių virkštelės kraujo serumo leptino kiekis. Įvertinta 112 nėščiųjų antropometrija: KMI (lygus svoris (kg)/ ūgis (m^2)) bei pasyvi kūno masė – absoliutus ir santykinis riebalinio audinio kiekis bioelektrinio impedanso metodu.

Įvertintas 30 tik gimusių naujagimių svoris ir ūgis. Duomenys išreikšti aritmetiniu vidurkiu (M) su standartiniu nuokrypiu (MSD) ir koreliacine-statistine analize. Pateiktas statistinis patikimumas.

Rezultatai. Tirtų nėščiųjų kraujo serumo leptino koncentracija didėjo nuo nėštumo pradžios iki III nėštumo trimestro pradžios (22,24 ± 1,8 ng/ml iki 37,29 ± 1,93 ng/ml) ir ėmė mažėti artėjant gimdymui.

Nustatytas patikimas tiesioginis ryšys ($p < 0,0001$) tarp nėščiosios KMI, riebalinio audinio kiekio ir serumo leptino koncentracijos.

Patikimas ryšys ($p < 0,005$) rastas tarp virkštelės kraujo serumo leptino kiekio ir naujagimio svorio

Išvados. Tirtų nėščiųjų kraujo serumo leptino koncentracija didėjo ilgėjant nėštumo laikui, t. y. iki III nėštumo trimestro pradžios, ir laipsniškai mažėjo artėjant gimdymui. Ryškus nėščiųjų kraujo serumo leptino koncentracijos padidėjimas koreliuoja su nėščiosios KMI ir riebalinio audinio kiekiu. Nustatyta patikima virkštelės kraujo serumo leptino koncentracijos ir naujagimio svorio koreliacija.

Raktažodžiai: leptinas, nėštumas, KMI, riebalinis audinys