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Metabolic Disturbances in Obese Pregnant Residents of an Industrial Region (The Urals, Russia)

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ABSTRACT

Objectives: We sought to investigate the presence of metabolic disturbances in obese pregnant women living in an industrial city in Russia. ***Methods***: We retrospectively analyzed the ambulatory cards of 96 pregnant women with alimentary obesity (aged 23–34), their birth history, and their newborn development history (anamnesis). ***Results:*** Sixty-two percent of women had obstetric and gynecological complications. Pregnancy complications (gestational diabetes, risk of pregnancy interruption, toxicosis in the first half gestation, gestosis) were experienced in 36% of women. Increased glucose in the blood was accompanied by higher concentrations of atherogenic components (i.e., triglycerides and low density lipoproteins (LDL)). The imbalance of metabolic processes in the homeostatic system of pregnant obese women (total protein: 50.4 g/L, cholesterol: 6.1 mmol/L, LDL: 4.1 mmol//L, high density lipoproteins (HDL): 0.85 mmol/L, triglycerides: 3.5 mmol/L, glucose: 7.0 mmol/L) formed a pathogenic link in the development of obesity. ***Conclusions:*** Increased glucose and atherogenic lipid profile and decreased protein levels in the blood promote the processes of the adiposity in women and aggravate the pathological processes of gestation and the postnatal period. Pregnant obese women of reproductive age form a group at high risk of developing complications during gestation and parturition. Obesity is not a contraindication for pregnancy, although the risk of complications is great.

Excessive weight directly influencing health is a problem for a considerable number of people all over the world. According to World Health Organization (WHO) over 1.5 billion people suffer from obesity, which causes 2.8 million deaths annually.[1,2] The WHO has noted that in countries east of the Mediterranean Sea and the Americas, more than 50% of women are overweight.[1,2] Russia is no exception: obesity has increased 23% during the last 10 years, and continues to rise.[3–6] Alimentary obesity has become extended (obese primipara have had an alimentary, constitutional form of obesity since childhood): 21–25 year old women make up 30–32% and 26–30 year old women make up 26–28% of obese women.[7,8]

Obesity aggravates a pathological pregnancy and the postnatal period, increases the risk of morbidity and mortality among infants.[9-11] In Russia, infant mortality is three to four times higher than in other European countries.[1,2] This fact requires particular attention to determine the reasons for high prenatal morbidity and neonatal mortality. A number of complications resulting from obesity affect the health of the mother.[12–16] According to official statistics, population health in parts of Russia is getting worse.[17,18] There are social and ecological reasons for alimentary adiposity.[19–21] Pregnant obese women require early diagnosis and prophylaxis of pathogenic disturbances, as they cause obstetric complications (e.g., insufficiency of placenta, gestosis, intrauterine hypoxia, and intrauterine growth restriction of the fetus).[22–24]

Adiposity is one of the most common forms of lipid metabolism disturbances in obese pregnant women. Despite the large number of studies on the etiology and pathogenesis of alimentary obesity in pregnant women, the problem of excessive weight directly influencing health is unsolved. Health protection in women and their newborns, especially in ecologically unfavorable regions, including the Urals, is necessary for national health.

We sought to investigate the characteristics of metabolic disturbances in obese pregnant women inhabiting an industrial city in Russia.

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METHODS

The research was carried out in the obstetric clinic of the Central Maternity Hospital in Yekaterinburg. We performed a sophisticated standard laboratory inspection of 96 nulliparous pregnant women between the age of 23–34 and their infants. We retrospectively analyzed the ambulatory cards of women, birth history, and their newborn development (anamnesis). Pregnant women with no heavy extragenital pathology, no obstetric traumas, no abnormal parturition, no alcohol and narcotic consumption were included in the study.

We also measured the height and body weight of all patients. Their body mass index (BMI) was calculated during the first trimester.[24] According to the WHO, overweight BMI is ≥ 25 kg/m^2 while obesity is a BMI ≥ 30 kg/m^2.

The state of infants immediately after birth was measured using the Apgar scale. This measures the infants activity, reflexes, and the activity of the respiratory and cardiovascular systems in the first minutes after birth. A score between 8–10 indicates a good state; 7 - between normal and pathology; 6 - light asphyxia; and 5–4 - heavy asphyxia or absence of positive dynamics.

The inspection included arterial pressure (AP) measurements performed using standard methods.[25] For the blood pressure measurements, we used the OMRON RX automatic monitor (Matsusaka Co. Ltd, Japan). Blood pressure values are given in mm of mercury (mm Hg).

A complex prenatal ultrasonic inspection of each pregnant woman was made. This included evaluation of the fetal biophysical profile and dopplerometric estimation of the blood stream in the umbilical cord arteries using ultrasonic scanners Aloka-SSD-1400 (Japan) and Sonoline G-40 Siemens-Acuson (Germany).

According to the ultrasonic and dopplerometric results, two groups of the studied women were found: the obese women and the control group. Dopplerometric inspection during the second and third trimester allowed us to predict fetal heavy and middle degree intrauterine hypoxia and intrauterine growth restriction of the fetus.[26,27]

Blood samples from the pregnant women were taken for analysis from the elbow vein before parturition. The blood of the newborn was taken from the umbilical cord vein. The blood was collected into Vacutainers (Becton Elmer, US). The blood indices were assessed on the automatic biomedical analyzer BC-5800c Shenzhen Mindray (China).

In all women, the total protein, carbohydrate metabolism, and lipid spectrum of the blood serum were estimated by standard methods using a Specord M-40 spectrophotometer (Carl Zeiss, Jena, Germany). Blood serum samples were separated at 2000 rpm in a K-23D refrigerated ultracentrifuge (Germany). Blood was centrifuged for 10 minutes. Standard enzymatic methods defined glucose and triglycerides in the blood with the use of BioSystems sets (Spain).[28,29] The protein content was estimated by the Lowry method using bovine serum albumin as the standard.[30]

Results were processed using Microsoft Exel 2003 and Statistica (StatSoft, Ink., 1984–2001) version 6.0. The results were reported as a mean ± standard error of the mean, or as median and range. The student's *t*-test analyzed parameters showing a normal distribution, and for parameters showing a non-linear distribution and between groups the Mann-Whitney U test was used. The distinctions between the groups were considered to be statistically significant at $p < 0.050$.

The study protocol was approved by the Medical Ethics Committee of the Ural State Medical University in Yekaterinburg, and discussed in detail with each volunteer before she gave her written consent to participate in the research, according to the tenets of the Declaration of Helsinki. The confidentiality of the collected data was guaranteed in the protocol.

RESULTS

All mothers included in the study were Yekaterinburg residents. The control group contained 46 healthy women with physiological pregnancy and parturition (normal body mass, no heavy somatic pathology) and their 46 newborn babies. They had spontaneous delivery, and pregnancy was not complicated in 17% of cases, but 9% of women had hypertension. The control group included 46 healthy young women (BMI = 22.3±1.9 kg/m^2). Of the infants born to these women, 85% had proportional physical development. The average body mass of the infants was 3446.8±146.2 g. The average score on the Apgar scale for the newborn babies was 8.6±0.5 [Table 1].

In the case group, there were 50 pregnant women with alimentary obesity: 25 (50%) women with

Table 1: Characteristics of pregnant women and infants, and pregnancy complications.

Characteristics	Control group, n = 46	Obese group, n = 50
Pregnancy complications	▪ 100% physiological pregnancy and parturition ▪ BMI = 22.3±1.9 kg/m^2 ▪ 17% overburdening obstetric and gynecologic anamnesis ▪ 15% iron deficiency anemia ▪ 9% hypertension ▪ 27% extragenital infections and non-infectious diseases	▪ 50 (100%) alimentary obesity ▪ 25 (50%) obesity degree I ▪ 14 (28%) obesity degree II ▪ 11 (22%) obesity degree III ▪ 62% overburdening obstetric and gynecological anamnesis ▪ 60% iron-deficiency anemia ▪ 36% gestosis ▪ 40% hypertension ▪ 38% placental insufficiency ▪ 26% premature parturition (degree II, III obesity) ▪ 76% extragenital diseases of infectious-inflammatory character (degree I, II obesity) ▪ 100% extragenital infections and non-infectious diseases (degree III obesity)
Newborns, n = 96	▪ 39 (84.7%) mature newborn and proportional physical development ▪ 85% healthy ▪ 15% chronic hypoxia ▪ 8% intrauterine growth retardation ▪ 7% slight anemia ▪ 3% average anemia ▪ Average Apgar scale score (one after birth): 8.6±0.5	▪ 30 (60.0%) mature newborn and proportional physical development ▪ 45% healthy ▪ 26% premature ▪ 44% chronic hypoxia ▪ 24% intrauterine growth retardation ▪ 30% slight anemia ▪ 12% moderate anemia ▪ 6% severe anemia ▪ 15% purulent-septic diseases ▪ Average Apgar scale score (one minute after birth): ▪ babies born to degree I and II obese woman – 7.6±0.3. ▪ babies born to obese woman degree III – 6.2±0.2.

Obesity degree I: mean BMI = 31.7±1.5 kg/m^2; obesity of degree II: mean BMI = 36.8±3.1 kg/m^2; obesity of degree III: mean BMI = 41.6±1.4 kg/m^2.

obesity degree I (mean BMI = 31.7±1.5 kg/m^2); 14 (28%) women had degree II obesity (mean BMI = 36.8±3.1 kg/m^2), and 11 (22%) women had degree III obesity (mean BMI = 41.6±1.4 kg/m^2) [Table 1]. Sixty-two percent of women in the group had overburdening obstetric and gynecologic anamnesis, somatic pathology, and pregnancy complications. Seventy-six percent of women in the obese group had extragenital diseases of an infectious-inflammatory character (degree I, II obesity) and 100% had extragenital infections and non-infectious diseases (degree III obesity). These extragenital diseases imply a lower immunological and non-specific resistance of the patient.

Gynecological diseases in obese pregnant women (BMI > 30, > 35, > 40) were similar regarding frequency and structure and differed only in degree. The main complications were gestoses (36%), and premature parturition (26% of degree II and III obese women). Nephropathy was observed at all obesity stages, and 38% had placental insufficiency. Obese women had higher levels of cardiovascular diseases. Examination showed that 60% had iron-deficiency anemia. Anemic obese women had a high perinatal risk for newborn babies, as 48 anemic babies were born to them.

Complications in pregnancy and parturition heighten the frequency of sequelae among infants. Chronic hypoxia of various degrees was observed in 22 infants (44%). This group included 13 infants from mothers with degree II and III obesity. The average score on the Apgar scale for 11 infants born to degree III obese woman was 6.2±0.2 [Table 1]. Ten healthy infants (20%) with a body mass of 3101.2±145.5 g were born to women with degree I obesity. Twelve infants had a body mass of 2425.0±91.2 g.

Intrauterine growth restriction was recorded in 24% of infants. In four women with degree III obesity, macrosomia and postmaturity accompanied by intrauterine hypoxia was observed. Their infants had a body mass of 4430.0±35.3 g. For the babies born to women with degree I and II obesity, the average score on the Apgar scale in the first minute after birth was 7.6±0.3. For infants born to women

Table 2: Biochemical indices in the blood serum of pregnant women.

Attribute	Control group (n = 10)	Degree I obesity (n =14)	Degree III obesity (n = 10)
Total protein, g/L	63.0±2.4	54.0±5.6*	50.4±0.6*
Cholesterol, mmol/L	4.2±0.02	5.0±0.04**	6.1±0.01**
Low density lipoproteins, mmol/L (LDL)	2.8±0.31	3.8±0.61*	4.1±0.75**
High density lipoproteins, mmol/L (HDL)	1.3±0.12	1.0±0.01*	0.85±0.04*
Index - atherogenesis	2.2	3.9*	6.1*
Triglycerides, mmol/L	1.6±0.03	2.6±0.02*	3.5±0.02*
Glucose, mmol/L	4.2±0.2	6.6±0.2*	7.0±0.3**

Data given as mean±SE.
*Significant at *$p < 0.050$; **$p < 0.010$ = differences between the case and control groups.*

with degree III obesity, the average score on the Apgar scale in the first minute after birth was 6.2±0.2.

The analysis of hemodynamic indices in the umbilical cord artery showed higher systolic-diastolic ratios in the obese group compared to the control group (3.6±0.01 and 2.4±0.03, respectively; $p < 0.050$). Resistance index values also revealed a deterioration in fetal blood circulation: 0.8±0.1 in the obese group and 0.6±0.07 in the control ($p < 0.050$). A critical state of the blood circulation in the umbilical cord artery (degree III obesity) was seen in seven infants (intrauterine growth retardation syndrome).

In all pregnant women, indices of AP were analyzed. Somatically healthy young women from the control group had normal AP (diastolic arterial pressure (DAP) range = 60–81 and systolic arterial pressure (SAP) range = 90–119). In women with increased body weight, arterial hypertension was noted. The comparative analysis showed that 9% of somatically healthy women with normal body weight had hypertension, and 40% of women with degree II and III obesity had arterial hypertension. Indices of blood pressure variability in hypertensive patients were the following: DAP range = 85–99 and SAP range = 130–151.

The disturbances in the adaptive-homeostatic status of functional communications in the mother-infant system manifested themselves as metabolic complications during the gestation period. Metabolic disturbances are known to be the basis for limitations in the transformation of lipids, carbohydrates, and proteins. To assess the metabolic disturbances in pregnant women, we estimated the glucose, protein, and lipid spectrum in blood serum. In the control group, carbohydrate metabolism was undisturbed [Table 2].

Our results indicate hyperglycemia and moderate hypercholesterolemia in the blood of obese women. Unfavorable changes were marked in the blood lipid profile: increased levels of triglycerides, total cholesterol and LDL ($p < 0.050$; $p < 0.010$). As shown in Table 2, HDL concentrations in the blood of obese women were significantly lower compared with the control group ($p < 0.050$). Lipid spectrum analysis revealed hyperlipidemia in the degree III obesity cases. An atherogenic lipid profile was observed against the background of decreased protein metabolism ($p < 0.050$). Some researchers have suggested that excessive body weight increases the risk of gestational diabetes.[31-34] Four pregnant women with degree III obesity had hyperglycemia (7.1–7.5 mmol/L in the blood serum), accompanied by postmaturity and macrosomia (infant body mass 4430.0±35.3 g).

We noted earlier a significant deterioration in obstetric indices and complications in pregnant residents of ecologically unfavorable cities.[35] Excessive weight in women is an additional unfavorable factor for their fetus and infant: extremely high hypoxia levels and fetal macrosomia, anemia, intrauterine growth restriction syndrome, a risk of pregnancy interruption and increased reproductive losses were noted [Table 1].

DISCUSSION

Pregnant women of reproductive age with alimentary obesity form a group at high risk of the development of complications during the gestational period and during parturition. We investigated 96 pregnant women between the ages of 23 to 34 and their newborn babies; 62% of obese women had complications in their obstetric and gynecological

anamnesis. Lipid metabolism alterations were characterized by significantly increased levels of triglycerides, cholesterol, HDL and LDL in cases of degree I and III obesity ($p < 0.050$).

Our data show that glucose levels in the blood (fasting) were significantly higher in obese woman than in the control group ($p < 0.050$; $p < 0.010$). No carbohydrate metabolic disturbances were revealed in the control group. Among obese women, carbohydrate metabolic disturbances were observed in 22.1% in the first trimester, 27.3% in the second trimester, and 32.1% in the third trimester. The results indicate that increased glucose and atherogenic lipid profile and decreased protein levels in the blood promote the processes of the adiposity in women and aggravate the pathological processes of gestation and the postnatal period.

The present study indicates that pregnancy complications (gestational diabetes, risk of pregnancy interruption, toxicosis in the first half of gestation and gestosis) were found in 36% of obese women.

Considering the fact that physiological pregnancy is accompanied by fat accumulation, it is necessary to control the imbalance of metabolic processes (proteins, lipids and carbohydrates). The assessment of obese women should include an estimation of serum lipid levels and glucose tolerance beginning at 10 weeks of pregnancy. Diagnostics and optimization of treatment of obese women by methods of metabolic correction are possible in practical medicine.

CONCLUSION

The reproductive health of women is one of the primary problems in the Sverdlovsk region. Obesity is one of the most socially significant chronic diseases. Obesity is not a contraindication for pregnancy, although the risk of complications is considerably increased. In these cases, women need diet therapy, gynecological observation, endocrinology assessments, and metabolic control during pregnancy.

Disclosure

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