# The Influence of Glycemic Control During Pregnancy on the Development of Offspring of Diabetic Mothers

**Jūratė Buinauskienė**

*Kaunas Medical University, Neonatology Clinic, Kaunas, Lithuania*

**Evelina Buinauskaitė**

*Kaunas Medical University, Kaunas, Lithuania*

**Vitalija Marmienė**

*Kaunas Medical University, Psychiatric Clinic, Kaunas, Lithuania*

The aim of the study was to evaluate the influence of mothers‘ glycemic control during pregnancy on the physical and psychomotor development of offspring of type 1 diabetic mothers. The developmental analysis embraced 51 offsprings of mothers with type 1 diabetes. The glycemic control during pregnancy was good in 33 (64.7%) mothers, and in 18 (35.3%) cases it was poor or satisfactory. We found that there was a significantly lower rate of main neonatal complications when the mothers' diabetic control during pregnancy was good. The weight of offspring correlated with diabetic control during pregnancy: 72.5% of the offspring of type 1 diabetic mothers had a normal weight when the mothers' glycemic control was good and 50% when it was poor or satisfactory. The impaired fine motor function, receptive language, self-dependence and social adaptation correlated with the degree of diabetic control during pregnancy and the influence of glycemic control was not significant for the neurobehavioral functions such as expressive language, auditory and visual attention and memory.

Conclusion: Poor metabolic control during pregnancy is the most important factor for the development of offspring born to women with diabetes (type 1), which increases the risk for obesity and disorders of psychomotor development.

**Key words**: glycemic (diabetic) control, type 1 diabetes, obesity, psychomotor development

## INTRODUCTION

Offspring born to women with pregnancies complicated by type 1 diabetes form an exclusive population, which practically was still unknown thirty years ago. The mother's disease affects the development of these fetuses during all developmental stages of their intrauterine life. The fetus should constantly get appropriate amounts of various substances from his mother during the normal pregnancy. The fetus of a diabetic mother grows up in an abnormal metabolic environment, as excessive quantities of glucose, lipids and amino acids get through the placenta from the mother.

In the developed countries, the perinatal mortality of diabetic women has become equal to the perinatal mortality of healthy ones and in the developing countries it significally decreased when glycemic control was started to be done several times a day and insulin injections were started to be used at least four times a day (1, 2). Nevertheless, even now when the intensive care became available for diabetic women, their pregnancy still is a big risk both in obstetrics and in neonatology (8, 9). A correlation has been found between the degree of mother's hyperglycemia during pregnancy and obesity, psychomotor development and diabetes of offspring later in their lives (3–6).

**The aim of the study** was to evaluate the influence of mothers‘ glycemic control during pregnancy on the physical and psychomotor development of 2–5 year old children of type 1 diabetic mothers.

## MATERIALS AND METHODS

The developmental analysis embraced 51 offsprings of type 1 diabetic mothers (ODM) who gave birth in the period of 1997–1999 in the Kaunas Medical University Hospital. The sample size was selected to evaluate the statistic significance ($p < 0.05$). A standard ques-

Correspondence to: Jūratė Buinauskienė, M. D., Ph. D., Neonatology Clinic, Kaunas Medical University, Eivenių 2, LT-3007, Kaunas, Lithuania. E-mail: jbuinauskiene@yahoo.com

tionnaire was used. It was composed of questions about mothers' disease and glycemic control during pregnancy, neonatal complications and physical and psychomotor development of offspring at 2–5 years of age.

The weight and height were measured using standardized methods. The psychomotor development of the 2–5-year-old children was evaluated by the Diagnostic Inventory for Screening Children (DISC) method (7). Standard tables were used to interpret the results. The results were compared with normatives and between the groups. The relative weight (the current weight/ideal weight ×100) was valuated by the following criteria: <90% – undernutrition, 90–110% – normal weight, > 110–120% – overweight and >120% – obesity. Newborns whose birthweight exceeded the 90th percentile were classifed as large for gestational age, i.e. they were macrosomic. Diabetic control during pregnancy was evaluated according to the criteria determined by WHO (8): good – fasting plasma glucose 4.4–6.7 mmol/l, postprandial 4.4–8.9 mmol/l; satisfactory – fasting plasma glucose ≤7.8 mmol/l, postprandial ≤10.0 mmol/l; poor – fasting plasma glucose >7.8 mmol/l and postprandial >10.0 mmol/l.

The analysis was performed using the standardized software packages: SAS, Statistica 5.5, Epi-info 6.0, MS Excel 2000, SPSS 8.0. Statistical characteristics such as average ± SD, median, quartiles were used to evaluate uniform dimensions. The Mann–Whitney U test was used to check the hypothesis of average differences. The dependence of children's development on mothers' glycemic control during pregnancy was evaluated using the $\chi^2$ test. The $p$ values <0.05 were considered statistically significant.

## RESULTS

The glycemic control during pregnancy was good for 33 (64.7%) observed mothers, and in 18 (35.3%) cases it was satisfactory or poor (Fig. 1). The average age, weight, height, body mass index (BMI) before pregnancy, the number of pregnancies and deliveries, family status and background did not significantly differ in both groups of mothers. Gestational age and the age at examination, male and female percentage in both groups did not significantly differ. It was noted that the average birth weight (3497.0 ± 892.4 g) and height

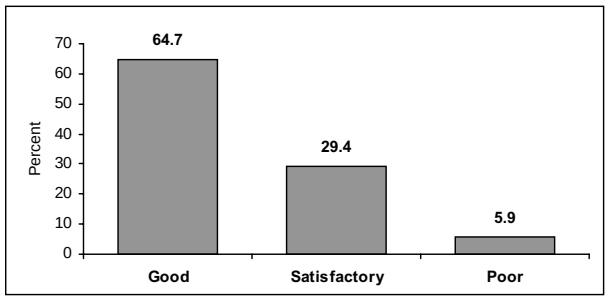


Fig. 1. Glycemic control during pregnancy

(52.6 ± 4.6 cm) of children whose mothers' glycemic control during pregnancy was poor or satisfactory were significantly higher when compared to the children whose mothers' glycemic control during pregnancy was good (3182.5 ± 720.0 g and 50.5 ± ± 5.3 cm). For 11 (61.1%) newborns whose mothers' glycemic control during pregnancy was satisfactory or poor the birth weight was more than 90 percentile, i. e. they were macrosomic.

When diabetic control during pregnancy was good (Table 1), there were significantly less neonatal complications such as hypoglycemia, hyperbilirubinemia, infectious complications and congenital malformations; the frequency of polycytemia and respiratory distress syndrome had the tendency to be lower.

Offspring whose mothers' glycemic control during pregnancy was good had a significantly higher rate of normal weight when compared to the ones whose mothers' glycemic control was satisfactory or poor (Table 2).

Table 1. **Glycemic control and neonatal complications**

| Indices | Good glycemic control n = 33 (%) | Poor and satisfactory glycemic control n = 18 (%) | p |
|---|---|---|---|
| Macrosomia | 15 (45.5) | 12 (66.6) | <0.05 |
| Hypoglycemia | 8 (24.2) | 9 (50.0) | <0.05 |
| Hyperbilirubinemia | 18 (54.5) | 14 (77.8) | <0.05 |
| Polycytemia | 3 (9.1) | 2 (11.1) | NS |
| Respiratory distress syndrome | 5 (15.1) | 4 (22.2) | NS |
| Infectious complications | 2 (6.1) | 5 (27.8) | <0.05 |
| Congenital malformations | 5 (15.1) | 6 (33.3) | <0.05 |

Table 2. **Glycemic control and weight of offspring**

| | Good glycemic control n = 33 (%) | Poor and satisfactory glycemic control n = 18 (%) | p |
|---|---|---|---|
| Underweight | 2 (6.1) | 3 (16.7) | NS |
| Normal weight | 24 (72.7) | 9 (50.0) | <0.05 |
| Overweight | 4 (12.1) | 3 (16.7) | NS |
| Obesity | 3 (9.1) | 3 (16.7) | NS |

Glycemic control during pregnancy was particularly important for the psychomotor development of ODM: glycemic control was found to exert a significant influence on the childrens' fine motor function, receptive language, self-dependence and social adaptation when compared to children with normal psychomotor development (Fig. 2). The expressive language, auditory and visual attention and memory in both groups were equally poor, i. e. there were few ODM with normal development of these functions in both groups.

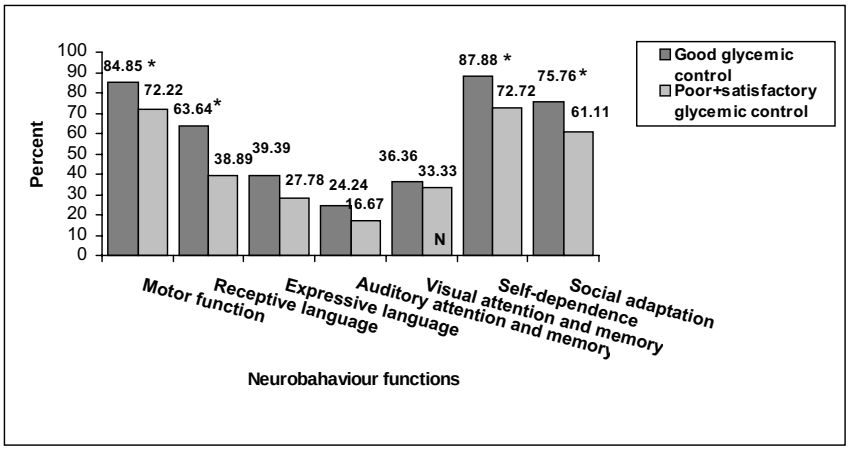


Fig. 2. Glycemic control and normal psychomotor development of offspring

## DISCUSSION

The results of this study demonstrate the importance of strict glycemic control during pregnancy for the development of ODM. We found that only 5.9% women with type 1 diabetes had a poor glycemic control during pregnancy. This means that the glycemic control during pregnancy became much better in Lithuania when the management of pregnant diabetic women became centralized and coordinated (1).

Our data showed that there was a significantly lower rate of neonatal complications when glycemic control during pregnancy was tight. These results confirm the data of recent studies that neonatal complications are related to poor control of diabetes, and hypoglycemia of ODM develops when mothers' hyperglycemia causes a constant fetus' hyperinsulinism because of the pancreas beta cell hypertrophy and hyperfunction (9). Neonatal complications as macrosomia and congenital malformations can be reduced only by normalizing women's glycemia before pregnancy (10). Our study suggests that the care of pregnant diabetic women is a very important factor which decreases the possibility for a disordered development of ODM.

Our data showed that 72.7% of ODM whose mothers had a good glycemic control had normal weight when compared to 50% of ODM whose mothers had a poor or satisfactory glycemic control. The variations of children's weight are related to hyperinsulinemia and abnormal concentrations of glucose and amino acids (11). The undernutrition of ODM mostly correlated with congenital anomalies (29.6%) when glycemic control was poor and there were vascular complications of diabetes. Similar data were offered by F. P. Dune, O. Langer and D. Conway (9, 12). Nowadays the problem is to evaluate if a good glycemic control of mothers really decreases the possibility of obesity as it decreases the possibility of fetal macrosomia (13). R. Sinha noted that obesity was related to the risk of unbalanced glucose tolerance or even of an early development of type 2 diabetes later in life (14).

The rate of disorders of psychomotor development was significantly lower when the mothers' metabolic control during pregnancy was good, and all these disorders were significantly more frequent among children of mothers with a poor diabetic control. G. Ircha, B. L. Silverman and T. A. Rizzo present similar data (3, 15). The influence of glycemic control on the retardation of child's development can be explained by the effect of the mother's metabolism and unfavourable diabetic environment and neonatal complications associated with the mother's disease (15–17). N. Weintrob noted that the influence of neonatal complications could be reduced by adequate care of a pregnant woman and her newborn (18). Even in 1979 N. Freinkel stated that normal nutritional substances depending on their concentration could act as pharmacological factors during pregnancy of diabetic women. Perinatal hypoxia and oxydative stress increase the risk for developing hypoglycemia in the ODM (19, 20). The frequency of neonatal complications has a direct correlation with diabetic control during pregnancy and psychomotor development of ODM (15, 21). The recent studies showed that diabetes can cause long-lasting neurologic disorders as it disturbs the development of the child's brain. These neurologic disorders manifest as motoric and attention disorders, hyperactivity and subtle neurologic symptoms under the effect of mother's metabolic factors, and they correlate with the mother's glycemic control (3.21).

The development of ODM is closely linked with mothers' metabolism, and the psychomotor development of ODM is tightly associated with physical development, especially with the children's overweight and

obesity. T. A. Rizzo notes that when a diabetic mother notices her child's tendency to obesity, she starts worrying that her child is also ill with diabetes. The mother's stress is the state to which the child responds with anxiety/depression, somatic disease and/or disturbances of behaviour at school and lack of communications with peers (6). Though good glycemic control reduces the negative effect of diabetes on childrens' physical and psychomotor development, the danger still remains when the diabetes control is poor. These results amplify the importance of the mother's glycemic control.

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**J. Buinauskienė, E. Buinauskaitė, V. Marmienė**

**MOTINOS GLIKEMIJOS KONTROLĖS NĖŠTUMO METU ĮTAKA TOLESNEI PIRMO TIPO CUKRINIU DIABETU SERGANČIŲ MOTERŲ VAIKŲ RAIDAI**

S a n t r a u k a

Darbo tikslas – įvertinti motinos glikemijos kontrolės nėštumo metu įtaką tolesnei pirmo tipo cukriniu diabetu sergančių moterų vaikų fizinei ir psichomotorinei raidai. Tirta 51 cukriniu diabetu sergančios moters vaikų raida. Gera glikemijos kontrolė nėštumo metu buvo 33 (64,7%) tiriamųjų vaikų motinų, 18 (35,3%) – bloga ar patenkinama. Nustatyta, kad esant gerai motinos diabeto kontrolei nėštumo metu, naujagimystės laikotarpio komplikacijų būna statistiškai mažiau. Normaliai svėrė 72,7% pirmo tipo cukriniu diabetu sergančių moterų vaikų, kurių motinų glikemijos kontrolė nėštumo metu buvo gera, ir 50% vaikų, kurių motinų glikemija bloga ar patenkinama. Glikemijos kontrolė turėjo statistiškai reikšmingą įtaką tiriamųjų vaikų smulkiajai motorikai, kalbos suvokimui, savarankiškumui ir socialinei adaptacijai, o ekspresyviosios kalbos, girdimojo ir regimojo dėmesio funkcijoms ta įtaka nebuvo reikšminga. Išvada: bloga motinos diabeto kontrolė yra svarbus veiksnys, didinantis riziką pirmo tipo cukriniu diabetu sergančių moterų vaikų raidos sutrikimams.

**Raktažodžiai:** Glikemijos (diabeto) kontrolė, pirmo tipo cukrinis diabetas, nutukimas, psichomotorinė raida