The Relationship between Maternal Glucose Concentration and Mothers Conditions in Pregnancy and BMI of Infants and School-Aged Children

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Abstract

Objective: The high prevalence of Gestational Diabetes Mellitus (GDM) in Iran and its maternal and fetal consequences as well as the high risk of its long-term effects including obesity is known. The aim of this study was to evaluate the relationship between body mass index (BMI) in ages of 18 months and 6 years and maternal glucose concentration.

Materials and Methods: This is a retrospective cohort study conducted on 199 pairs of mother and child in five health-care centers of Yazd. The children born in 2007 and 2008 were selected, followed by a calculation of BMI in the ages of 18 months and 6 years (school age) based on their heights and weights recorded in their family files. The relationship between the resulting BMI and maternal glucose concentration and pregnancy conditions was then determined.

Results A population of 199 mother-child pairs were investigated consisting of 105 male children (52.8%) and 94 female ones (47.2 %). The mean (±SD) glucose challenge test (50 gram -GCT) and pre-pregnancy BMI were 121(25.7) mg/dL and 24.16 (4.85) kg/m^2, respectively. At 18 months, the mean (±SD) child BMI was 15.78 (1.21) kg/m^2, 5.5% of which were overweight/obese and at 6 years, the mean (±SD) child BMI was 14.46 (1.81) kg/m^2, 12.6% of which were overweight/obese. This study revealed a significant association between BMI 18 months and 6 years and pre-pregnancy BMI with maternal GCT (P-value <0.003). Therefore, GCT ≥ 130 mg/dL compared with GCT <129 mg/dL significantly associated with BMI at 18 months and 6 years old and the mother's pre-pregnancy BMI.

Conclusion: According to this study, it can be concluded that there is a significant correlation between GCT and the increase of children BMI. It is necessary to control and treat gestational diabetes mellitus by means of decrease the intergenerational cycle of obesity and diabetes in offspring. Also infants of women with diabetes should be specifically targeted for obesity prevention programs.

Keywords: Glucose screening test, Obesity, Pregnancy, Gestational diabetes mellitus, Child health

Introduction

A large amount of healthcare budget is spent on chronic diseases among which diabetes has a prominent position. On the other hand, it is known that pregnancy is regarded as an important period of life during which the risk of developing diabetes increases due to high insulin resistance.

Diabetes in pregnancy turns into a kind of carbohydrate intolerance with variable

intensity which starts and is detected in early stages of pregnancy (1,2). Any disruption in glucose metabolism during pregnancy can lead to a great deal of maternal (pre-eclampsia, hypertension, and increase in caesarean section) as well as fetal (macrosomia, hypoglycemia, hypocalcaemia, hyperbilirubinemia, and respiratory distress syndrome) complications (3,4). Thus, both mother and child are to be subject to further analysis from now on.

The most significant threat for the fetus is extra weight which is caused by the passage of glucose from the mother to the embryo and its exposure to the mother's high glucose level leading to obesity and diabetes in long term (5-13).

Despite being internationally prevalent, this syndrome has different patterns of distribution in different regions of the world. This difference depends on the different populations and diagnostic criteria (14).

Gestational diabetes has been increasingly becoming prevalent over the past two decades. In Iran, it has been increasing by a percentage of 1.3 to 8.9 in different provinces (15,16).

A great number of studies have been conducted ever since on gestation of diabetes and its maternal-fetal complications such as diabetes and obesity after delivery and later in life (17,18).

In a study, which was conducted in India, on 552 children born from mothers with glucose tolerance between the ages of 5-24 years, the positive correlation between high maternal glucose concentration and the risk of obesity and diabetes at older ages was proved (19).

On the other hand, in a retrospective cohort study done on children between the age of 2 and 4 years old, Childhood obesity was not associated with GDM but was associated with higher pre-pregnancy maternal BMI (20).

In another study, carried out on American 5-7-year-old children, suggest that increasing hyperglycemia in pregnancy is associated with an increased risk of childhood obesity (21).

Furthermore, Pettit and coworkers did not report a significant relationship between gestational glucose and the infants' obesity at 2 years of age (22).

Deierlein found a noticeable relation between glucose concentrations above 130 mg/dL and BMI Z-score in 3-year old children (23).

The reports on the outbreak of obesity specially among children and young adults over the past fifty years and concerns about the effect of obesity on development of diseases like diabetes as well as the above-mentioned contradictions and controversies in achieved results became the motives of this study.

Materials and Methods

This study was done on 199 mother-child pairs in five health-care centers of Yazd, Iran. The family profiles of the children born in 2007-2008 were analyzed through the following procedure. First, the case number of the vaccinated child (at the age of 6) was written down from the database in vaccination departments in health-care centers. Then, an appropriate number of samples were selected systematically from among them. In this study, BMI was calculated based on the height and weight information provided by the family profile through which the relationship between BMI and 50 gram glucose challenge test as well as gestational conditions was determined.

Other gestational information including age of conception, gestational age, pre-gestational BMI, glucose concentration of mothers prone to gestational diabetes in the first pre-natal visit (measuring FBS), glucose concentration in all mothers at gestational age of 24-28 weeks (GCT with 50 gram glucose), nulliparity/multiparity, mother's level of education and method of delivery (normal vaginal/ caesarian/forceps), and the infant's height, weight, and head circumference were registered and analyzed based on the family files.

The data were then analyzed using SPSS18 and T-test, Chi-Square, Pearson and Regression Correlation Coefficients.

Results

In sum, 199 mother-child pairs were analyzed in this study including 105 males (52.8%) and 94 females (47.2%). Regarding the method of delivery, 100 infants were born through normal vaginal delivery (50.3%) and 99 through Caesarean Surgery (49.7%). Based on the data provided, method of delivery, infant's weight at birth, and gestational age correlated significantly (*P*-value<0.008). A number of 124 mothers (62.3%) did not have a high school diploma, 60 of them (30.2%) had diploma and the rest (7.5%) had higher degrees.

The biggest number belongs to nulliparous mothers who were 86 in number (43.2 %).

The average neonatal weight is 3100±458 gr (1400 - 4200 gr). The average weight, height, and BMI in 18-month-old infants were 10.5±1.18 kg, 81±3 Cm, and 15.78±1.21 kg/m^2 respectively based on which 12 cases were reported to be overweight (5.5%).

The average weight, height, and BMI in six-year-old children were 19±3.33 kg, 114±4.75 Cm, and 14.46±1.81 kg/m^2respectively and 24 overweight/obese cases were detected on the ground of these results. The average FBS in mothers prone to diabetes was 84.5±13.43 mg/dL (60-180 mg/dL).

The average GCT in mothers was 121±25.74 mg/dL ranging from 78 to 239 mg/dL. There was a remarkable correlation between the infant's weight, height, and BMI at 18 months of age and weight, height, and BMI at the age of six years old, mother's age and GCT (*P*-value ≤0.05).

Based on the information provided there was a noticeable relation between BMI at 18 months as well as 6 years of age and BMI of the mother before pregnancy and GCT during pregnancy (Table 1) which leads us to the conclusion that glucose concentration of higher than 130 mg/dL dramatically correlates with BMI at ages of 18 months and 6 years in infants and the mothers BMI before pregnancy (*P*-value≤0.05).

Discussion

Pederson put forward a theory encompassing long-term exposure of the fetus with high glucose concentrations during pregnancy in mothers suffering from diabetes and its relation with hyperinsulinemia and fetal

Table 1. Relationship between BMI at different ages with mothers' gestational glucose concentration

Variable		Birth BMI	BMI 18 months of age	BMI 6 year-old	Mothers BMI	FBS (Mother)	GCT (50gram)
Birth BMI N=199	Pearson Correlation Coefficient						
	P-value						
BMI 18 months of age N=199	Pearson Correlation Coefficient	0.149					
	P-value	0.036					
BMI 6 year-old N=199	Pearson Correlation Coefficient	0.160	0.458				
	P-value	0.024	0.000				
Mother's BMI N=199	Pearson Correlation Coefficient	0.034	0.161	0.309			
	P-value	0.735	0.103	0.002			
FBS	Pearson Correlation Coefficient	-0.061	0.221	0.192	0.230		
	P-value	0.452	0.006	0.016	0.037		
GCT	Pearson Correlation Coefficient	-0.50	0.258	0.292	0.314	0.571	
	P-value	0.522	0.001	0.000	0.003	0.000	

adiposity (17). Since then, numerous studies have been conducted on pregnant women and its maternal/fetal complications including being overweight/obesity at the time of birth or later on.

In two other studies one of which was done on 552 Indian children at the age of 5 to 24 years old in 1992 and the other on 9430 American children (5 to 7 years old), maternal glucose concentration and the increasing risk of obesity and diabetes type 2 were found to be directly correlated(19,21).

On the other hand, in another retrospective Cohort study on 2-4-year-old children born to mothers with/without gestational diabetes between 2004 and 2007, a number of 225 pairs of mother-child (mothers recorded with GDM) were evaluated. The results, however, revealed no significant difference in BMI percentile of children born to mothers recorded with/without GDM (20).

In this retrospective Cohort study which has been done on 199 pairs of mother-child in towns with populations of less than 20000 in the city of Yazd, no remarkable relation between glucose and BMI at birth and maternal Glucose concentration was reported, while the BMI at the ages of 18 months and 6 years as well as maternal BMI before gestation correlated significantly with maternal glucose concentration in gestation (P-value ≤ 0.05).

In the present study, GCT≥130 mg/dL as opposed to GCT≤129 mg/dL had a meaningful relation with BMI in the ages of 18 months and 6 years as well as maternal BMI before pregnancy.

Deierlein concluded that GCT≥130 mg/dL as opposed to GCT <100 mg/dL doubles the risk of obesity at the age of 3 which is compatible with our findings (23).

Regarding the fact that high maternal glucose concentration is a preventable and variable and considering other available evidence showing that treatment of gestational hyperglycemia can cut down on the adverse effects of birth such as macrosomia eventually lowering the risk of obesity, it is hoped that the adverse implications be reduced through in-time diagnosis of maternal diabetes, testing glucose concentration of all mothers, reducing the diagnosis threshold from 140 to 130 mg/dL, post-diagnosis care including nutrition consult, laboratory, regular visit by gynecologist and endocrinologist.

One of the limitations in this study was lack of sufficient recorded information of the mothers in their family profile. Another limitation is presence of some other altering factors (noise) such as environmental factors (nutrition and child's diet, exercise) with its highest impact at the age of 6.

Conclusion

There is a significant correlation between GCT and the increase of children BMI. It is necessary to control and treat gestational diabetes mellitus by means of decrease the intergenerational cycle of obesity and diabetes in offspring. Also infants of women with diabetes should be specifically targeted for obesity prevention programs. Also due to the lack of similar studies in Iran, more studies of this type can help improve well-being of mothers and children.

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