Original Article

Characteristics of Gestational Diabetic Mothers and Their Babies in An Indian Diabetes Clinic

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Abstract

Aims and Objectives : To compare clinical and metabolic features of mothers with gestational diabetes (GDM) and their offspring with those in non-diabetic pregnancies at the King Edward Memorial Hospital, Pune, India.

Materials and Methods : Antenatal information was obtained from hospital records. GDM was diagnosed by 75 g OGTT (Oral Glucose Tolerance Test) in clinically high-risk women. Anthropometric measurements of mother and the babies were recorded within 24h of delivery and a maternal blood sample collected for hematological and biochemical measurements.

Results : Between the period Jan 1998 to December 2003, 265 women with gestational diabetes were treated in our Unit. Forty nine percent had first-degree relatives with diabetes. Compared to non-diabetic mothers (n=215) GDM mothers were older (29.0 vs. 26.0y, $p<0.001$), more obese (body mass index- BMI 26.0 vs. 22.0 kg / m^2, $p<0.001$), centrally obese (Waist hip ratio-WHR 0.89 vs 0.86, $p<0.001$), adipose (sum of 4 skinfolds 98.4 vs. 61.4 mm, $p<0.001$) and had higher blood pressure (127 / 80 vs. 122 / 70 mmHg, $p<0.001$). GDM mothers had higher concentrations of plasma triglycerides (195.0 vs. 153.0 mg / dl, $p<0.01$); blood hemoglobin (11.7 vs 10.9 g / dl, $p<0.001$) and higher platelet count but lower concentration of HDL cholesterol and albumin.

Sixty percent GDM mothers and 34% of non-diabetic mothers were delivered by caesarean-section, 23% of GDM mothers delivered pre term (<37 wk). Despite the smaller gestation, babies of GDM mothers were heavier (BW 2950.0 vs. 2824.0g, $p<0.001$, adjusted for gender), longer (48.9 vs. 48.0 cm, $p<0.01$) and more adipose (sum of 2 skinfolds 10.5 vs. 8.5 mm). Only 5% of babies born to GDM mothers weighed > 4000 g but 30% were >90th centile of birth weight of babies born to non-diabetic mothers. Babies of GDM mothers suffered higher neonatal morbidity.

Conclusions : GDM mothers in urban India are more obese and more adipose than non-diabetic mothers, frequently have a family history of diabetes and show metabolic features of insulin resistance syndrome, suggesting high cardiovascular risk. Neonates of GDM mothers are heavier, longer and more adipose than those born to non-diabetic mothers, and suffer higher neonatal morbidity. ©

Introduction

Gestational Diabetes Mellitus (GDM) is defined as glucose intolerance that has its onset or first recognition during pregnancy.[1] GDM is common in populations who have high rates of type 2 diabetes. Common risk factors for GDM include familial predisposition, higher age, overweight, and previous history of large babies.[2] Recently, small birth weight and short height (of the pregnant woman) have also been shown to increase risk of GDM.[3] India has the highest number of patients with type 2 diabetes in the world[4] but only sparse information is available on the prevalence, predictors and the risks of GDM in India.

GDM increases the risk of bad outcome in the pregnancy for both the mother and the baby, and also increases the risk of 'permanent' diabetes for the mother.[5-7] GDM mothers have an excess of metabolic risk factors, which qualify them for the diagnosis of the metabolic syndrome and an increased cardiovascular risk.[8,9] We have reported on the high incidence of type 2 diabetes and metabolic syndrome 4 years after delivery in GDM mothers in our clinic.[10] In this present study we compare the characteristics of GDM mothers treated in our Diabetes Clinic, their pregnancy outcome and the characteristics of their babies with those of non-diabetic mothers and their babies treated in the same hospital.

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Material And Methods

We studied retrospectively women with gestational diabetes mellitus (GDM) treated in Diabetes Unit, King Edward Memorial (KEM) Hospital, Pune, India during the period Jan 1998 to December 2003 to compare the characteristics of GDM pregnancies with a non-diabetic group. We collected comparable information from non-diabetic mothers delivered in the KEM Hospital during Feb-May 1998. The KEM Hospital provides obstetric services to the local population and also provides secondary and tertiary services for women in Pune city and surrounding villages. Approximately 1500 women deliver every year in this hospital. There is no universal screening for diabetes in pregnancy. Women thought to be at high risk of diabetes by the treating obstetrician undergo a 75 g OGTT; these include: women with first degree relatives with diabetes, bad obstetric history, overweight, excessive weight gain during pregnancy, those with glycosuria or a high random plasma glucose, hypertensive, ultra-sonographic diagnosis of macrosomic baby, polyhydramnios or a congenital anomaly.

GDM was diagnosed by WHO-1998 criteria;[11] both impaired glucose tolerant and diabetic women were considered as having gestational diabetes. They were treated as per an agreed protocol. Dietary advice included sugar restriction, increased fiber rich foods and frequent small feeds rather than two major meals. Exercise advice was in consultation with the obstetrician, for most women it was walking for at least 20 minutes daily. If plasma glucose concentrations were still elevated after 1 week of dietary adjustment (fasting plasma glucose >95 mg/dl and 2h post meal ≥ 140 mg/dl), insulin treatment and home monitoring of blood glucose was advised. Obstetric management followed the Hospital protocol for high-risk pregnancies. This included serial sonography to date the pregnancy, diagnose fetal anomalies, and monitor fetal growth. Non-stress testing (NST) was performed after 34 wks of gestation. Treating obstetrician decided appropriate time and mode of delivery. Informed consent was obtained from the patients for anthropometric and blood measurements and the Hospital Ethical Committee approved the study.

Measurements

Maternal information during pregnancy was obtained from outpatient records. This included medical and obstetric history, the time and the results of the glucose tolerance test, and the time and the mode of delivery. Gestational age at delivery was calculated from the last menstrual period, supported by sonographic findings. Maternal venous blood sample was collected soon after delivery.

Anthropometry

Standardized anthropometric measurements were made in duplicate on the left side by two trained observers within 24 hrs of delivery. Mean of two measurements was used in analysis. Maternal measurements included weight using Soehnle electronic scales, height using Harpenden Stadiometer; biceps, triceps, subscapular, and suprailiac skinfolds using Harpenden skinfold calipers; and head, midarm, waist and hip circumferences using a non-stretchable fiberglass measuring tape. All the anthropometric instruments were supplied by CMS Instruments, London, UK. Blood pressure was recorded in sitting position using a mercury sphygmomanometer.

Neonatal measurements included: weight using ATCO scale (Wadala, Mumbai, India); crown-heel length using Pedobaby; subscapular and triceps skinfolds on the left side of the body using Harpenden skinfold calipers and head, mid-upper arm, abdominal, and chest circumferences using a non-stretchable fiberglass measuring tape. Placenta was weighed soon after birth after cutting the cord flush and trimming off the membranes.

Maternal blood measurements

Maternal venous blood was collected soon after the delivery. Hematological measurements were made on a Coulter analyzer A^{c}T diff ™ (Beckman, Miami, FL, US). Plasma measurements included: glucose, albumin, total and high-density lipoprotein (HDL) cholesterol and triglycerides. These were performed using standard clinical laboratory methods on a Spectrum Biochemistry Analyzer (Abbott Laboratories, Irwing, TX, US).

Controls

We collected similar information at delivery in mothers without diabetes who delivered in the KEM Hospital during the period Feb 1998 to May 1998. Those who delivered full term with uncomplicated pregnancies and had fasting plasma glucose concentrations <90 mg/dl and 2h post meal < 120 mg/dl during pregnancy were selected as controls.

Statistical Methods

Data is shown as mean (SD) for normally distributed variables and as median (IQR) for those not normally distributed. The latter were log transformed to ensure normality during statistical analysis. Group comparisons were made using chi-square test. The significance of the difference between means of the two groups was analysed by ANOVA with adjustments for confounding variables as appropriate. Multiple linear regression was used to determine the effects of maternal characteristics on the size of the newborn. Analysis was carried out using STATA (version 7.0) (Stata Corporation, TX, USA).

Results

Pregnancy characteristics

GDM

Three hundred and thirty three pregnant diabetic

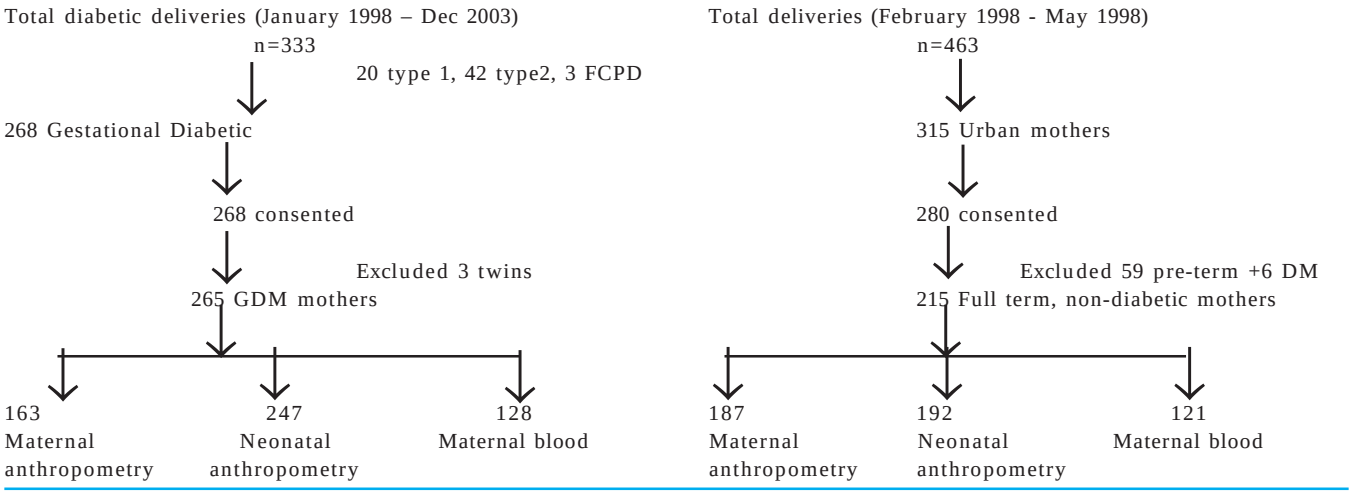

Fig. 1 : Flow chart showing selection of GDM mothers, their babies and controls.

women were referred to the Diabetes Unit for management during the period Jan 1998 to Dec 2003. Sixty-five women had pre-gestational diabetes (20 type 1, 42 type 2 and 3 fibro-calculous pancreatic diabetes) and 268 had gestational diabetes. Three women delivered twins. Further analysis therefore refers to 265 singleton gestational diabetic pregnancies. Anthropometric measurements were available on 163 mothers (Fig. 1) and 247 neonates; post-delivery blood results were available on 128 women.

Mean gestation at diagnosis of GDM was 32 wks (range 26-35 wks), 150 women had IGT and 115 had diabetes by the WHO 1998 criteria. Eighty six percent mothers were primiparous. One hundred and twenty eight (48%) mothers had a first-degree relative with diabetes. Mean gestation at delivery was 38 wks, 61 women (23%) delivered pre-term (<37 wks). One hundred and fifty-eight women (60%) were delivered by caesarean section. There were 4 intrauterine deaths (IUD) and 56 babies were diagnosed with a neonatal complication (2 respiratory distress, 20 hypoglycemia, 12 jaundice, 2 sepsis, 5 congenital anomalies, 17 other).

One hundred and sixty-two women (61%) received insulin treatment and 103 (39%) women were treated with diet and exercise. Insulin treatment was started at a mean gestation of 28 weeks. Median insulin dose was 20 units / d (8-105 units / d), 14 women received >1unit / kg / d. Oral hypoglycemic agents were not used but majority of women were prescribed guar-gum (Carbotard, Jagat Pharma, Pune).

Controls

Of 463 non-diabetic mothers delivered in the KEM Hospital during Feb-May 1998, 315 were residents of Pune. Two hundred and fifteen delivered full term (≥ 37 week of gestation). Anthropometric measurements were available on 187 mothers and 192 neonates, and post-delivery blood results on 121 women.

Of 215 non-diabetic mothers 68.0% were primiparous. Mean gestation at delivery was 39 wks. Sixty-six (31.0%) were delivered by caesarean section. There were no IUDs, and none of the babies was clinically diagnosed with any complications or congenital anomalies.

Anthropometry and blood pressure: (Table 1)

Because of significant differences between GDM and non-diabetic mothers all anthropometric and blood measurement comparisons are adjusted for age, parity and gestation at delivery. GDM mothers were heavier, more obese (higher BMI) and more centrally obese (higher WHR) compared with non-diabetic mothers. All skin fold thicknesses were significantly higher in GDM mothers (adiposity) including in mothers who had BMI< 25 kg / m^2. GDM mothers had significantly higher blood pressure.

Blood measurements: (Table 2)

GDM mothers had higher concentration of blood hemoglobin, higher hematocrit and higher platelet count but not red cell and total leucocyte count compared to non-diabetic mothers. GDM mothers also had higher concentrations of plasma triglycerides and lower concentrations of plasma HDL cholesterol compared to those in the non-diabetic mothers. This was also true in mothers who had a BMI <25 kg / m^2 (Data not shown).

Metabolic syndrome variables: (Table 3)

GDM mothers had higher prevalence of overweight and obesity (BMI>25 kg / m^2), central obesity (WHR>0.85), hypertriglyceridemia (plasma triglyceride>150 mg / dl) and hypertension (blood pressure>140 / 90 mm Hg) compared to the non-diabetic mothers.

Comparison of mothers with IGT and DM

Diabetic mothers were older than those with IGT (31 vs. 29y, $p<0.01$). Both groups had similar body size measurements and other biochemical parameters. Mothers with diabetes had higher systolic blood pressure ($p<0.01$). Sixty four percent of diabetic mothers and 54% of IGT mothers underwent caesarean section (p=ns).

Table 1 : Maternal anthropometric characteristics of GDM and non-diabetic mothers

Characteristics	GDM (163)	Non-diabetic (187)	p	p1
Age (y)	29.6 (4.6)	25.6 (4.1)	<0.001	—
Gestation at delivery (wk)	37.9 (2.8)	39.4 (1.7)	<0.001	—
Maternal weight (Kg)	64.0 (56.8-71.5)	51.5 (45.5-59.0)	<0.001	ns
Maternal height (cm)	154.4 (5.3)	153.0 (5.7)	<0.05	ns
Body mass index (kg/m^2)	26.3 (24.2-29.4)	21.9 (20.0-24.7)	<0.001	<0.001
Circumference (cm)				
Head	53.8 (2.3)	53.6 (2.4)	ns	ns
Waist	93.5 (86.8-100.1)	80.6 (75.2-87.5)	<0.001	<0.001
Hip	102.7 (97.2-111.0)	93.8 (88.3-98.7)	<0.001	<0.001
Waist-hip ratio	0.89 (0.06)	0.86 (0.06)	<0.001	<0.01
Midarm	28.0 (26.3-30.4)	24.7 (22.8-26.9)	<0.001	<0.001
Skinfolds (mm)				
Biceps	11.3 (7.9-15.8)	7.3 (5.6-9.6)	<0.001	<0.001
Triceps	22.2 (16.7-27.5)	13.8 (10.8-17.8)	<0.001	<0.001
Subscapular	31.5 (24.4-40.0)	20.0 (15.0-26.7)	<0.001	<0.001
Suprailiac	31.0 (22.7-40.0)	16.5 (12.7-22.0)	<0.001	<0.001
Sum of 4 skinfolds	98.4 (30.9)	61.4 (22.3)	<0.001	<0.001
Blood pressure (mmHg)	127/80	122/70	<0.01	<0.01
Insulin treatment (%)	60.0	—	—	—
Caesarean section (%)	60.0	33.0	<0.001	—

Mean (SD) or median (Inter Quartile Range) except for blood pressure where only mean is shown. p1 adjusted for maternal age, parity and gestation at delivery (ANOVA).

Table 2 : Hematological and metabolic parameters in GDM and non-diabetic mothers

Characteristics	GDM (n=128)	Non-diabetic (n=121)	p	p1
Hemoglobin (g/dL)	11.7 (1.7)	10.9 (2.1)	<0.01	<0.001
Hematocrit (%)	34.9 (4.9)	31.6 (5.6)	<0.001	<0.001
Platelet count (x 10^3/L)	225.9 (106.9)	135.6 (39.6)	<0.001	<0.001
Total leucocyte count (x 10^3/L)	14.6 (5.7)	16.0 (5.3)	<0.05	ns
Red blood cell count (x10^6/L)	4.2 (0.6)	4.1 (0.6)	ns	ns
Total plasma cholesterol (mg/dl)	196.4 (54.0)	203.8 (44.5)	ns	ns
Plasma HDL cholesterol (mg/dl)	44.0 (33.8-54.0)	44.0 (36.0-54.0)	<0.001	<0.01
Plasma triglyceride (mg/dl)	195.0 (152.0-245.0)	153.0 (121.0-185.5)	<0.001	ns
Plasma albumin (g/dl)	3.2 (0.5)	3.4 (0.5)	<0.01	ns

Mean (SD) or median (IQR). p1 adjusted for maternal age, parity and gestation at delivery (ANOVA).

Table 3 : Cardiovascular risk factors in GDM and non-diabetic mothers

Characteristics	GDM n=163	Non-diabetic n=187	p
BMI>25 (kg/m^2)	68.0	21.0	<0.001
Waist-hip ratio >0.85	77.5	56.7	<0.001
Waist circumference >88 (cm)	72.5	23.0	<0.001
Plasma cholesterol ≥ 200 (mg/dl)	47.8	51.7	ns
Plasma triglycerides ≥ 150 (mg/dl)	75.8	54.2	<0.01
Plasma HDL cholesterol ≤ 39 (mg/dl)	38.9	33.6	ns
Hypertension (>140/90 mmHg)	23.5	12.4	<0.01

Values are percent. p by Chi-square test.

Comparison of insulin treated and diet treated GDM mothers: (Table 4)

Insulin treated mothers were older (31 vs. 28y, p<0.001), and more adipose (sum of four skinfolds 105.2 vs. 87.4mm, p<0.001). They had higher plasma glucose concentrations during diagnostic GTT (p<0.001), were diagnosed at an earlier gestation (p<0.05) and also delivered one week earlier (37.7 vs. 38.4wks, p<0.05). There was no significant difference in BMI, WHR, head circumference and blood pressure in the two groups.

Offspring characteristics: (Table 5)

Babies of GDM mothers were delivered one week earlier than the babies of non-diabetic mothers. All comparisons were corrected for gestation and gender. In addition GDM mothers were larger in size and had different parity therefore the neonatal comparison were further adjusted for maternal BMI and parity. Babies of GDM mothers were heavier (2936.0 vs. 2809.0g, p<0.001) compared to those born to non-diabetic mothers when adjusted for gender, gestation at delivery and maternal age and parity. This difference did not remain significant when adjusted additionally for maternal BMI or height. Thirty percent of babies of GDM mothers weighed more than 90th centile of birth weight of babies of non-diabetic

mothers (3269.0g). Five percent of babies of GDM mothers and 0.6% of babies of non-diabetic mothers had macrosomia (weight > 4000.0g).

Babies of GDM mothers were longer, had larger midarm and abdominal circumferences and subscapular and triceps skinfold thicknesses. There was no significant difference in the ponderal index and head and chest circumferences. Placenta of the babies of the GDM mothers was also heavier compared to the placenta of the babies of non-diabetic mothers. There was no significant difference in any of the anthropometric measurements of babies born to IGT or diabetic mothers or between those treated with insulin or diet.

In GDM pregnancies greater maternal height and larger waist circumference predicted higher birth weight of the baby (adjusting for gestation at delivery and gender). However in non-diabetic pregnancies higher maternal weight, head circumference, waist circumference and mid-arm were associated with higher weight of the baby.

In GDM pregnancies, maternal fasting and 2h plasma glucose concentrations at the time of OGTT did not predict birth weight of the babies, maternal biochemical parameters at delivery were also not related. In non-diabetic mothers, higher hematocrit, plasma cholesterol, triglycerides and albumin concentrations were associated with higher weight of the babies.

Mothers of the babies who had any complication at birth were diagnosed diabetic earlier in the pregnancy (27.5 vs. 30.5wks, p<0.04) and also delivered one week earlier (36.9 vs. 38.3wks, p<0.001). There were no other predictors of neonatal complications.

Table 4 : Comparison of insulin treated and diet treated GDM mothers

Characteristics	On insulin (162)	On diet (103)	p
Age (y)	30.6 (4.4)	27.9 (4.6)	—
Maternal weight (Kg)	66.6 (12.5)	61.6 (11.8)	<0.05
Maternal height (cm)	154.8 (5.5)	153.6 (4.9)	ns
Body mass index (kg/m^2)	27.7 (4.9)	26.1 (4.7)	ns
Circumference			
Head (cm)	53.8 (2.6)	53.8 (1.6)	ns
Waist (cm)	95.4 (9.4)	91.4 (11.5)	<0.05
Hip (cm)	105.5 (10.5)	103.0 (10.6)	ns
Waist-hip ratio	0.91 (0.07)	0.89 (0.06)	ns
Midarm (cm)	29.2 (3.9)	27.1 (3.9)	<0.01
Skinfolds			
Biceps (mm)	13.7 (6.0)	10.9 (5.5)	<0.001
Triceps (mm)	24.7 (8.1)	20.3 (7.7)	<0.001
Subscapular (mm)	33.2 (9.5)	28.6 (10.0)	<0.001
Suprailiac (mm)	33.1 (10.3)	27.6 (10.0)	<0.01
Sum of 4 skinfolds	105.2 (29.5)	87.4 (30.2)	<0.001
Blood pressure (mmHg)	128/81	125/77	ns
Gestation at delivery (wk)	37.7 (2.5)	38.4 (3.1)	—
Neonate birth weight (g)	2921.0 (658.1)	2959.4 (550.4)	ns
Placental weight (g)	492.4 (140.7)	499.1 (108.3)	ns
Caesarean section	102 (64.0%)	56 (53%)	—

Mean (SD). p adjusted for maternal age and gestation at delivery (ANOVA).

Discussion

The results confirm the premise that excess of traditional risk factors for type 2 diabetes (family history of diabetes and obesity) and cardiovascular disease occur in Indian GDM mothers as compared to non-diabetic mothers. This suggests that pregnancy is a window to future cardiovascular risk.[9] Babies of GDM mothers were larger and more adipose compared to babies of non-diabetic mothers.

Using WHO criteria only a third of these mothers had diabetes while two thirds had IGT. Despite this, one week

Table 5 : Anthropometric characteristics in babies of GDM and non-diabetic mothers

Characteristics	GDM (247)	Non-diabetic (192)	P	p1	p2
Boys (%)	59	47	<0.05	—	—
Birth weight (g)	2936.1 (617.2)	2809.3 (383.6)	<0.001	ns	ns
Birth weight-Boys (g)	3002.8 (633.9)	2850.7 (366.2)	<0.01	ns	<0.05
Birth weight- Girls (g)	2836.0 (586.0)	2768.8 (397.6)	<0.01	ns	ns
Length (cm)	48.7 (2.4)	47.8 (2.0)	<0.01	<0.01	<0.001
Ponderal index (kg/m^3)	2.5 (0.4)	2.6 (0.3)	ns	ns	ns
Circumference					
Head (cm)	33.5 (1.4)	33.3 (1.4)	ns	ns	ns
Chest (cm)	31.8 (2.3)	31.7 (1.9)	ns	ns	ns
Abdomen (cm)	30.1 (2.5)	28.8 (2.4)	<0.001	<0.001	<0.001
Midarm (cm)	10.1 (1.2)	9.8 (0.8)	<0.01	ns	<0.05
Skinfolds					
Triceps (mm)	4.3 (5.4-6.3)	3.7 (4.3-5.0)	<0.001	<0.001	<0.001
Subscapular (mm)	4.1 (5.2-6.1)	3.7 (4.1-4.6)	<0.001	<0.001	<0.001
Placental weight (g)	494.9 (128.6)	416.8 (100.1)	<0.001	—	—

Mean (SD) or Median (IQR), p adjusted for gender, gestation at delivery, maternal age and parity (ANOVA). p1 adjusted for gender, gestation at delivery, maternal age, BMI and parity (ANOVA). p2 adjusted for gender, gestation at delivery, maternal age, height and parity (ANOVA).

after nutritional treatment, sixty percent mothers exceeded the target glycemic levels for good control and were put on insulin treatment. Incidence of maternal morbidity was substantial including pre-term delivery and caesarean section. The rate of caesarean section was similar in mothers with IGT or diabetes, but insulin treated women had higher rates. Insulin treated mothers were older, more adipose and not unexpectedly had more severe diabetes which was diagnosed at an earlier gestation.

Even though the GDM mothers were older than the non-diabetic mothers, the mean age of GDM mothers under study was only 29 years, and the youngest GDM mother was 20y old. Thus, Indian GDM women are younger compared to white Caucasian GDM women (mean age 33 years).[6] This reflects the tendency of Indians to acquire type 2 diabetes at a younger age when compared to white Caucasians.[12,13] The most striking physical characteristic of the GDM mothers was their increased obesity as compared to the non-diabetic mothers. Even those who were 'normal' by current BMI criteria (<25 kg/m^2, WHO 2004)[14] were more adipose (higher body fat percent). Indians are reputedly more adipose for a given BMI compared to other races and ethnic groups.[15-18] In this clinic-based study we were not able to confirm the previous observation of smaller height as predictive of GDM.

GDM mothers in our study showed an excess of cardiovascular risk factors mostly related to insulin resistance and the metabolic syndrome (obesity, adiposity, central obesity, higher plasma triglyceride concentration and higher blood pressure). The elevated blood hemoglobin concentration in the GDM mothers is not easy to interpret. It could indicate a relatively smaller volume expansion in GDM mothers (an unfavorable factor for fetal growth) or it could reflect better iron status due to better dietary intake or supplementation in a more closely supervised pregnancy. Higher platelet count in the GDM mothers is suggestive of a prothrombotic state, and with higher blood pressure suggests endothelial dysfunction.[19] Thus, these findings during pregnancy in GDM Indian mothers anticipate the heightened risk of metabolic syndrome and cardiovascular risk, which we have reported in these mothers 4y after the delivery.[10]

Despite earlier delivery, mean birth weight of babies of GDM mothers was higher than that in those of non-diabetic mothers. And the difference was predominantly in the soft tissues (adiposity, abdominal circumference and midarm circumference); skeletal measurements except height were similar. This observation fits well with the general concept of stimulated insulin dependent growth in babies of diabetic mothers.[20] It is relevant to note that only 5 percent of the babies of GDM mothers were 'macrosomic' by international definition (>4000g). However, a third of the babies of GDM mothers were heavier than 90th centile for babies of non-diabetic mothers. Caution should be exercised when using international criteria to describe morbidity in Indians.

Maternal glycemia at the diagnosis of GDM did not predict baby's birth weight, nor did maternal circulating lipids and albumin concentrations at delivery. This may partly be attributable to the phenotype modification by the anti-diabetic treatment. On the other hand, higher circulating cholesterol and triglyceride concentrations in non-diabetic mothers predicted larger birth weight in the babies.

The information on the neonatal morbidity was obtained retrospectively form hospital records; therefore we have to interpret this with caution. Babies of GDM mothers had higher neonatal morbidity (hypoglycemia, respiratory distress, sepsis etc). The only predictors of neonatal morbidity were related to earlier delivery and early gestation at diagnosis of GDM, which indicates that some of these mothers may have been diabetic prior to pregnancy. Ours is a hospital-based study where only 'high risk' mothers are screened for diabetes. Thus, admittedly there is a likely bias in our sample. On the other hand our data represents the current clinical practice in a large teaching hospital. A prospective study with universal glucose tolerance testing prior to pregnancy would provide a more precise idea of the risk factors for GDM, as well as the risk to the pregnancy and the offspring.

In summary, the result shows that gestational diabetes mellitus occurs in relatively young urban Indian mothers who have a family history of type 2 diabetes and are adipose. Some of these women may have diabetes prior to pregnancy. These young women have metabolic abnormalities, which suggest increased cardiovascular risk. Obstetricians should practice universal screening for diabetes in urban mothers to improve the outcome both for the baby and the mother. There is a need for large controlled studies to confirm the risks of GDM for Indian mothers and their babies.

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