ORIGINAL ARTICLE

Prevalence and Factors Associated with Gestational Diabetes Mellitus among Antenatal Women at a Rural Health Center in Vellore

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Abstract

Background and Objectives: Gestational Diabetes Mellitus (GDM) has been well documented to be associated with significant mortality and morbidity among both mother and their offspring. Prevalence of GDM in India varies between regions and has been documented to be on the rise over the last two decades which is a public health concern and reflects an increase in the frequency of type 2 diabetes mellitus in these populations. This study aimed at estimating the prevalence of GDM among antenatal women attending a rural secondary care hospital in southern India and attempts to study associations between anthropometry, parental history, physical activity of pregnant women and GDM.

Methods: A hospital based cross sectional study was done among 630 pregnant women who were screened with oral glucose tolerance test between 24 and 28 weeks of gestation based on IADPSG criteria. Risk factors for developing GDM were assessed by conducting home visits to 75 women diagnosed to have GDM and 150 randomly selected women without GDM.

Results: Hospital based prevalence of GDM was 14% (95 % CI: 11.3% to 16.7%) and a significant rise in prevalence levels was noted with age. Women with family history of diabetes mellitus, women with body fat of more than 23% had 2.65 and 2.89 times significantly higher odds of developing GDM.

Interpretation and conclusion: Family history of diabetes and excess body fat are risk factors associated with GDM. Among them excess body fat could be an independent risk factor without the influence of foetal weight and preventive measures could be directed towards it.

Introduction

Hyperglycaemia is a common complication in pregnancy. The International Diabetes Federation (IDF) has estimated that one in six babies is born to women with hyperglycaemia and 16% of the hyperglycaemia among pregnant women is due to type 2 diabetes mellitus and the remaining 84% is gestational diabetes mellitus (GDM).[1] Previously, the World Health Organization (WHO) has defined GDM as any degree of glucose intolerance with onset or first recognition during pregnancy.[2] However, this definition does not help distinguish those with undiagnosed pre-existing type 2 diabetes from GDM. The possibility of GDM is considered when hyperglycaemia diagnosed at 24-28 weeks of gestation does not fulfil the criteria of overt diabetes.[3] GDM increases the risk of morbidity such as shoulder dystocia, birth trauma, hypertensive disorders in pregnancy, need for caesarean sections, macrosomia, neonatal hypoglycaemia, neonatal polycythaemia and neonatal hyperbillirubinemia.[1] Nearly half of those diagnosed to have GDM are estimated to develop type 2 diabetes mellitus within 5 years of the index pregnancy.[4]

These risk factors of GDM include maternal obesity (body mass index >30), previous baby with macrosomia (birth weight >=4.5kgs), previous history of GDM, history of diabetes mellitus among first degree relatives and members of ethnic groups which have high rates of diabetes mellitus.[5] South Asians have been found to have a higher risk of GDM when compared to others.[4] The Hyperglycaemia and Adverse Pregnancy Outcomes (HAPO) study showed that glycemic levels lower than the standard cut off levels prescribed by WHO led to adverse perinatal outcomes.[6] Therefore, the International Association of Diabetes and Pregnancy Study Group (IADPSG), 2008 guidelines recommends universal screening of pregnant women for GDM.[7] GDM would be diagnosed at first visit by either HBA1C ≥ 6.5% or Fasting Blood Glucose (FBG) ≥ 92mg/dl. Those who tested normal would again undergo testing between 24 to 28 weeks with Oral Glucose Tolerance Test (OGTT) with 75 g of glucose. The cut off values of blood glucose to call as GDM are ≥92,≥180 and ≥153 mg/dl on fasting,1 hour and 2hour testing post Glucose administration.The new IADPSG criteria can pick up even milder forms of GDM when compared to the previous criteria laid down by the WHO.[8]

The Diabetes in Pregnancy Study Group India (DIPSI) for screening and diagnosis of GDM had recommended 2-hour blood glucose estimation by Glucose Oxidase-Peroxidase method (GOD-POD) after administration of 75 grams of oral glucose and a value of

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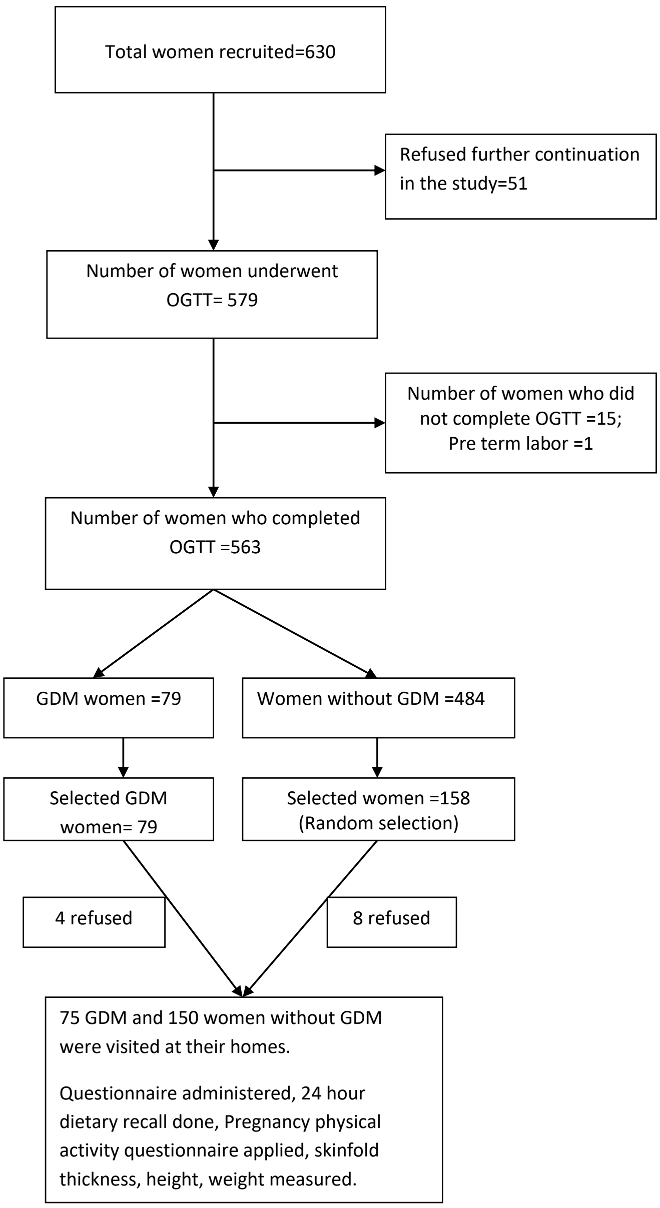

Fig. 1: Design of study

≥140 mg/dl is considered diagnostic of GDM.[9] Pregnant women need not be in a fasting state at the time of the test thus making it more convenient and reduces drop-out rates. The prevalence of GDM in India varies between regions and depends on the cut off value used for screening GDM. Hospital based prevalence rates of GDM have been estimated to be 7.1% in Haryana,[10] 41.9% in Lucknow, Uttar Pradesh.[11] In a community based study done in Chennai, the prevalence of GDM varied from 13.8% in semi urban and 9.9% in rural areas.[12] A prevalence study done in Tamilnadu showed the overall prevalence of GDM by IADPSG criteria to be 18.5% with no difference between rural and urban areas.[13] The increase in prevalence of GDM over the last 20 years could be attributed to certain changing trends, such as increasing maternal age, the epidemic of obesity, the increasing prevalence of type 2 Diabetes and overall increase in sedentary lifestyle.[4,13] The prevalence of GDM in south India was not clearly known when this study was started and Epidemiological data on modifiable risk factors for GDM were sparse. Being able to identify women at a higher risk for developing GDM is important as steps may be taken to decrease maternal and perinatal complications.[4] This study was conducted to estimate the burden of GDM, associated risk factors and prevalent dietary practices among pregnant women attending a rural secondary care facility in Tamil Nadu, India.

Material and Methods

A cross sectional study was conducted at the Community Health and Development (CHAD) hospital run by the Department of Community Health, Christian Medical College, Vellore between February to July 2015. This 120-bedded secondary level hospital primarily caters to the health needs of residents of Kaniyambadi block, a rural development block with a population of 1, 20,000 in Vellore district, Tamil Nadu. This hospital serves the residents of Kaniyambadi block and the neighboring towns and approximately has 88,726 outpatient visits annually with 20% (18,000) of these visits being for antenatal care (Annual Report 2015, Department of Community Health, CMC, Vellore).[15] This study was approved by the Review Board and Ethics Committee of the Institute [IRB Min No. 9191]. Informed Consent was obtained from all study participants.

With an assumed 15% prevalence of GDM based on earlier studies from similar settings in Tamil Nadu[12] the sample size was arrived at 567 women with 20% relative precision of P and 80%power. After allowance of 10% drop out the sample was rounded to 630 women. All consecutive pregnant women attending the CHAD general ante natal clinic for their first visit during their current pregnancy between 16 to 28 weeks of gestation irrespective of their parity, age and residing within 50 km radius of the hospital were included in the study. Women on drugs like steroids, olanzapine, phenytoin and thiazides and those with auto immune diseases were excluded from the study. Fifty-one of the 630 recruited women refused to continue in the study further. Oral Glucose Tolerance Test (OGTT) was scheduled and performed on 579 women between 24 and 28 weeks of gestation, at the laboratory run by the CHAD Hospital with 75 grams of glucose dissolved in water with lime added to it for better taste. Blood samples were drawn at fasting, 1 hour and 2 hours following oral glucose intake, blood glucose levels were estimated by the GOD-POD method. 15 women could not complete OGTT because of vomiting and one had pre term labor. GDM was diagnosed using

Table 1: Socio demographic characteristics of study population

		GDM n=75 (%)	NO GDM n=150(%)	p value
Education level	College	19(25.3%)	27(18%)	0.680
	Higher secondary	45(60%)	103(68.7%)	
	Up to high school	11(14.6%)	20(13.3%)	
Occupation	Home makers	71(94.7%)	141(94%)	0.895
	Professional / semi professional	0(0%)	4(2.6%)	
	Clerical/agriculture/shop owning	2(2.7%)	2(1.3%)	
	Semiskilled/student	2(2.6%)	3(2%)	
Socio economic status	High (class I,II,III)**	63 (84 %)	134(89.3%)	0.286
	Low (class IV,V)**	12(16%)	16(10.7%)	
Gravida	Primi gravida	34(45.3%)	74(49.3%)	0.384
	Gravida 2	26(34.7%)	50(33.3%)	
	Gravida 3 and above	15(20%)	26(17.33%)	
Parity	Para 0	40(53.3%)	85(56.7%)	0.417
	Para 1	27(36%)	51(34%)	
	Para 2 and above	8(10.6%)	14(9.3%)	
Maternal history of DM	Yes	18 (24%)	10(6.7%)	<0.001*
Paternal history of DM	Yes	15(20%)	16(10.7%)	0.056
Any parent DM	Yes	28(37.3%)	22(14.7%)	<0.001*
Both parents DM	Yes	5(6.7%)	4(2.7%)	0.150

*Statistically significant – Chi square test of proportions; **Modified Kuppusamy scale of socio economic status 2012

the IADPSG criteria if anyone value of blood sugar ≥ 92, 180, or 153 mg/dl at fasting, 1 or 2 hours following oral glucose administration.[7] Among the 563 women who completed OGTT 79 had GDM and 484 did not have GDM. All 79 GDM women were selected for home visits. A random sample of 158 women were selected from 484 women without GDM.A further drop out of 4 women from 79 women and 8 women from 158 women happened. Totally 75 GDM women and 150 women without GDM were visited at their homes and questionnaire administered (Figure 1). The person who visited the house of the participants was blinded to the results of the OGTT.

The questionnaire was a detailed structured one which looked at obstetric, family and medical history as well as socio-demographic details including age, education, occupation and family income. Dietary intake was assessed by a 24-hour recall method using standard cups, glasses, ladles and spoons. Anthropometric measurements including height, weight, biceps, triceps, subscapular skin fold thickness and mid upper arm circumference were taken using calibrated instruments and scales. Physical activity levels during pregnancy were assessed using the Pregnancy Physical Activity Questionnaire (PPAQ), a semi quantitative questionnaire.[16] Calorie intake was estimated using the values provided in the 'Nutritive Value of Indian Foods' database of the National Institute of Nutrition (NIN), India.[17] Socio economic status of the families was assessed using the Modified Kuppusamy scale 2012 which considered education and occupation of head of the family and monthly family income.[18] The body fat percentage was calculated from Skin Fold Thickness (SFT) and Mid Upper Arm Circumference (MUAC) using the following formula.[19]

Body fat % = 12.7+ (0.457 x triceps SFT) + (0.352 x subscapular SFT) + 0.103 x (Biceps SFT-0.057) x height + (0.265 x MUAC).

Data entry was done using Epidata version 3.1 and analysis using SPSS software version 18.0.[20] Overall and age specific prevalence rates of GDM were estimated. Bivariate analyses were done to study associations between age, education, occupation, socioeconomic status, family history of Diabetes, physical activity, Body Mass Index (BMI), body fat percentage and GDM. The median values of risk factors among the group without GDM were taken as the cut-off point to test their associations with GDM. The BMI value of 25 as per the international consensus on BMI for Asian Population[21] and moderate activity of 7.5 Metabolic equivalent on testing (MET) hours per week of physical activity for pregnant women synchronizing with American Council of Obstetrics and Gynecology (ACOG)[22] recommendations were taken as cut off values for testing associations with BMI and physical activity levels. Significance of difference in means of continuous variables among GDM and NO GDM groups was tested using Student't' test. Correlations were performed between continuous variables and Pearson correlation coefficients were estimated. Multivariate analysis by logistic regression was performed to adjust for confounders.

Results

Among the 630 women recruited, a total of 563 women completed OGTT. Prevalence of GDM based on IADPSG criteria among pregnant women attending the secondary hospital was 14.0% (79/563) (95% CI: 11.3% to 16.7%). Prevalence rates of GDM ranged from 9.6% (7/73); 10.4% (30/288); 16.9% (25/148) and 31.5% (17/54) among women aged up to 19; 20 to 24; 25 to 29 and above 29 years respectively. This increasing prevalence with age was statistically significant with Chi square value for trend analysis of 15.18, p <0.001.

Out of 79 women with GDM and 484 without GDM, 75 and 150 respectively were studied for risk factor analysis. Among them, 60% (45/75) of them had education up to higher secondary level and 94.7% (71/75) were home makers. In the group without GDM 68.7% (103/150) had studied up to higher secondary level and 94% (141/150) were home makers. The socio-economic status, obstetric status of women among both the groups was similar (Table 1). In the GDM group 24% (18/75) of the participants had maternal history of diabetes mellitus while it was 6.7% (10/150) among those without GDM and the difference was statistically significant by chi square test of proportions. About 37.3% (28/75) of women in the GDM group had history of diabetes in either parent where as it was 14.7% (22/150) among women without GDM (Table 1). By Student t tests comparing the means, it was found that the mean age, weight, biceps, triceps, subscapular skin fold thicknesses, mid arm circumference, BMI and body fat percentage were significantly higher among women who had GDM (Table 2). The mean calorie intake of the GDM and women without GDM were 2042.30 and 2323.63, mean physical activity was115.28 for GDM

Table 2: Anthropometry, BMI, Body fat and physical activity levels among women with and without GDM

	GDM n=75 Mean (SD)	NO GDM n=150 Mean (SD)	p value
Age in years	25.27(4.42)	23.21(3.80)	0.001*
Height in cm	152.43(6.43)	154.10(5.72)	0.049
Weight in Kg	57.47(11.44)	53.07(10.63)	0.005*
BMI	24.70(4.44)	22.30(4.03)	<0.001*
Biceps skin fold thickness (mm)	11.99(5.56)	9.78(5.04)	0.003*
Triceps skin fold thickness (mm)	19.46(4.81)	16.77(5.32)	<0.001*
Subscapular skin fold thickness (mm)	15.20(5.31)	13.34(4.66)	0.008*
Mid upper arm circumference (cm)	26.69(3.16)	25.35(3.23)	0.004*
Body fat%	26.56(4.78)	24(4.74)	<0.001*
Sedentary activity (MET hours/week)	31.51(25.41)	35.01(27.08)	0.353
Light activity (MET hours/week)	66.79(31.09)	62.79(27.12)	0.322
Moderate activity (MET hours/week)	20.18(21.42)	24.23(25.93)	0.244
Vigorous activity (MET hours/week)	2.07(5.20)	2.31(6.08)	0.770
Household/care giving activity (MET hours/week)	70.12(30.48)	73.44(35.80)	0.492
Occupational activity (MET hours/week)	5.58(23.39)	7.15(25.55)	0.656
Total activity (MET hours/week)	115.28(43.21)	118.83(43.21)	0.562
Calorie intake/day	2042.30 (597.08)	2323.63 (626.24)	0.001*

*Statistically significant – Student t test.

Table 3: Risk factors associated with GDM among the study participants

Factors		GDM n=75 (%)	NO GDM n= 150 (%)	Chi square p value	Unadjusted OR (CI)
Age	≥ 23 years	45(40.9%)	65 (59.1%)	0.018*	1.96 **
	< 23 years	30(26.1%)	85 (73.9%)		(1.11 to 3.44)
Education secondary	≥ higher	64 (33%)	130 (67%)	0.78	0.89
	< higher	11 (35.5%)	20 (64.5%)		(0.40 to 1.98)
secondary					
Occupation	Home maker	71 (33.5%)	141 (66.5%)	0.84	1.13
	Employed	4 (30.8%)	9 (69.2%)		(0.33 to 3.80)
Socio economic	High	63 (32%)	134 (68%)	0.25	0.62
Status	Low	12 (42.9%)	16 (57.1%)		(0.28 to 1.40)
Any parent	Yes	28 (56%)	22 (44%)	<0.001*	3.46**
Diabetes					(1.80 to 6.64)
Previous pre term	Yes	1(25%)	3 (75%)	0.668	0.60
Delivery (n=117)					(0.61 to 6.04)
Presence of bad obstetric	Yes	3(50%)	3(50%)	0.430	1.92
history (n=117)					(0.37 to 9.97)
Early pregnancy	> 50 kg	48(39.3%)	74(60.7%)	0.037*	1.82**
Weight	≤50 kg	27(26.2%)	76(73.8%)		(1.03to3.22)
Early pregnancy BMI	> 25	28(48.3%)	30(51.7%)	0.005*	2.38**
	≤ 25	47 (28.1%)	120 (71.9%)		(1.28 to 4.41)
Body fat %	> 23 %	60(43.5%)	78(56.5%)	<0.001*	3.69**
	≤ 23%	15 (17.2 %)	72 (82.8%)		(1.92 to 7.07)
Moderate Activity	≤ 7.5 MET	23(36.5%)	40 (63.5%)	0.529	1.21
in hours/week	>7.5 MET	52(32.1%0	110 (67.9%)		(0.66 to 2.23)

*Statistically significant p value<0.05

and 118.83 for women without GDM (Table 2). Though the mean calorie intake was significantly different in both the groups the physical activity levels were not significantly different between the groups.

Among anthropometric measurements, biceps skin fold thickness more than 8 mm, triceps skin fold thickness more than 16 mm, subscapular skin fold thicknesses more than 12.05 mm (p 0.002, <0.001, 0.018) and mid upper arm circumference more than 25 mm (p 0.006) were found to be significantly associated with GDM on Bivariate analyses. Other factors like gravida status more than 2, paternal history of diabetes, history of diabetes among both parents, higher education, occupation, socio economic status, previous history of pre-term birth, presence of bad obstetric history, moderate physical activity level of more than 7.5 MET hours/week were not significantly associated with GDM. Age more than 23 years (p=0.018), maternal history of DM (p<0.001), history of DM in any parent (p<0.001), early pregnancy weight more than 50 kg (p=0.037), early pregnancy BMI more than 25 (p=0.005), Body fat percentage more than 23% (p<0.001) were significantly associated with GDM (Table 3). Early pregnancy BMI and body fat percentage derived from skin fold thickness measurements between 24 to 28 weeks of pregnancy were found to be positively correlated with Pearson correlation co-efficient value was 0.78 (p value<0.001) and r^2 = 0.621 (Figure 2).

Factors which were significantly associated with GDM on unadjusted analyses like age, history of DM in any parent, and potential risk factors like physical activity were included for multi variate analysis. Multivariate analyses were performed using two models one with early pregnancy BMI and the other with body fat percentage. In model 1, multivariate analysis using binary logistic regression was performed including early pregnancy BMI and excluding body fat percentage. After adjusting for potential confounders, it was found that history of DM among any parent was significantly associated with developing GDM adjusted OR 2.91(95% CI: 1.48 to 5.72) (p =0.002). After adjusting for other variables, early pregnancy BMI did not have any significant association with GDM (Table 4).Body fat percentage was included in the second model along with other factors and it noted that that presence of DM in any parent and body fat percentage of more than 23% were significantly associated with GDM with adjusted OR 2.65 (95% CI: 1.34 to 5.25) and 2.89 (95% CI: 1.47 to 5.68) respectively (Table 4).

Discussion

Previous studies conducted at Tamilnadu had 13.8% and 9.9% prevalence of GDM at semi urban and rural areas respectively.[12] This present study conducted among antenatal women attending a secondary care rural hospital in Tamil Nadu has estimated the prevalence of GDM to be 14% (95% CI: 11.3 to 16.7%) similar to the previous studies although the prevalence is less when compared with another study done in Tamilnadu which had 18.5% prevalence of GDM with no rural and urban variations.[13]

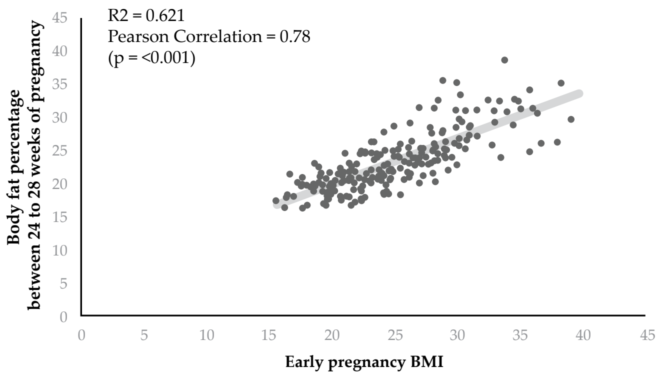

Fig. 2: Correlation between early pregnancy BMI and body fat percentage

Table 4: Multivariate analysis

Factors		Adjusted OR (CI)	
		Model 1	Model 2
Age years	≥ 23	1.54 (0.84 to 2.81)	1.45 (0.79 to2.65)
Any parent Diabetes	yes	2.91 (1.48 to 5.72)*	2.65 (1.34 to 5.25)**
Moderate Activity MET in hours/week	≤ 7.5	1.18 (0.89 to 3.36)	1.18 (0.61 to 2.26)
Early pregnancy BMI	> 25	1.73 (0.61 to 2.25)	Not included
Body fat %	> 23 %	Not included	2.89 (1.47 to 5.68)**

*Statistically significant at p<0.05 adjusted for age, family history of diabetes, physical activity and early pregnancy BMI. **Statistically significant at p<0.05 adjusted for age, family history of diabetes, physical activity and body fat percentage.

This study has demonstrated a rising prevalence of GDM with age, similar to a Turkish study,[23] however, on multivariate analysis after adjusting for confounders, this effect of age was not found to be statistically significant. Family history of diabetes in any parent increased the risk of developing GDM (adjusted OR = 2.65) (95% CI: 1.34 to 5.25) further emphasizing the importance of family history of diabetes with GDM there by reconfirming the genetic causes associated with GDM similar to a study done at Norway.[24]

During pregnancy, the BMI of the woman naturally increases due to physiological changes and developing fetal components and hence pre-pregnancy BMI is considered a more reliable indicator of obesity. In a retrospective cohort study done in Slovenia it was found that GDM was associated with higher pre pregnancy BMI 27±6.1 kg/m^2 with p value <0.001 in singleton pregnancies.[25] In the same study, smaller changes in BMI was associated with GDM in twin pregnancies p value<0.001. In the present hospital based study as pre-pregnancy weight was not available, early pregnancy weight was considered for BMI estimation. The obese with BMI more than 25 calculated using the earliest recorded pregnancy weight had a significant association with GDM (p value=0.005) and OR of 2.38 (95%CI: 1.28 to 4.41), but this association lost significance on multivariate analysis.

It appeared that women without GDM were more physically active than those with GDM but was not significant. This could be because of all the women visited, majority were house wives in both the groups and were performing similar levels of activity. Similarly, the dietary mean calorie intake between both the groups was significantly different in Bivariate analysis with GDM women consuming less than women without GDM. It could be because of some of the limitations of the 24-hour recall technique and the possibility that some of the study participants altering their dietary habits after they had known about their GDM status from other sources. After adjusting for age, family history and physical activity levels, body fat content was significantly associated with GDM adjusted OR 2.89 (95% CI: 1.47 to 5.68) and thereby could be considered as an independent risk factor without the influence of weight of the fetus unlike BMI. Similar result was obtained in a multi centric study conducted by Oslo university where it was found that weekly increase in truncal body fat of 0.14 kg was associated with occurrence of GDM with adjusted OR of 1.31 (95% CI: 1.10 to 1.56).[26]

The obtained prevalence and increasing trend of prevalence with age suggests universal screening of GDM as recommended by International federation of OBG (FIGO) and IDF. The less resource settings could follow the simple single step testing approach as recommended by DIPSI. Measures are needed to prevent the emergence of risk factors like excess body fat.

Conflicts of interest

There are no conflicts of interests. This study was funded by fluid research grant of Christian Medical College, Vellore affiliated with The Tamilnadu Dr. M.G.R medical university.

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