Indian J Med Res 137, April 2013, pp 728-733

Prevalence of gestational diabetes mellitus & associated risk factors at a tertiary care hospital in Haryana

Rajesh Rajput, Yogesh Yadav, Smiti Nanda* & Meena Rajput**

*Departments of Medicine VI & Endocrinology, *Obstetrics & Gynaecology & **Community Medicine, Community Medicine, Pt. B.D.S. Post Graduate Institute of Medical Sciences, Rohtak, Haryana, India*

Received May 18, 2011

***Background & objectives*: Prevalence of gestational diabetes mellitus (GDM) is known to vary widely depending on the region of the country, dietary habits, and socio-economic status. This study was undertaken to determine the prevalence of GDM and risk factors associated with it, in women attending an antenatal care (ANC) clinic at a tertiary care hospital in Haryana.**

***Methods*: This study enrolled women, with their estimated gestational age between 24th and 28th week, attending antenatal care (ANC) clinic at a tertiary care hospital in Rohtak. After informing, women who consented to participate were given a standardized 2-h 75 g oral glucose tolerance test (OGTT). A proforma containing general information on demographic characteristics, socio-economic status, education level, parity, family history of diabetes and/or hypertension and past history of GDM was filled up. American Diabetes Association (ADA) criteria for 75 g 2-h OGTT was used for diagnosing GDM.**

***Results*: A total of 607 women participated in the study and GDM was diagnosed in 43 (7.1%) women. A single abnormal value was observed in additional 66 (10.87%) women. On bivariate analysis risk factors found to be significantly associated with GDM were age, educational level, socio-economic status, pre-pregnancy weight and BMI, weight gain, acanthosis nigricans, family history of diabetes or hypertension and past history of GDM but on multivariate analysis only upper middle class and presence of acanthosis nigricans were found to be significantly associated with GDM.**

***Interpretation & conclusions*: The prevalence of GDM was found to be 7.1 per cent in a tertiary care hospital in Haryana. Appropriate interventions are required for control and risk factor modifications.**

Key words Blood glucose - GDM - Haryana - OGTT - prevalence

The prevalence of diabetes mellitus (DM) is increasing worldwide and more in developing countries including India. The increasing prevalence in developing countries is related to increasing urbanization, decreasing levels of physical activity, changes in dietary patterns and increasing prevalence of obesity[1-5]. As women with gestational diabetes mellitus (GDM) and their children are at increased

risk of developing diabetes mellitus in future, special attention should be paid to this population especially in developing countries.

GDM is defined as glucose intolerance of varying degree with onset or first recognition during pregnancy[1]. Prevalence of gestational diabetes mellitus varies widely. Depending on the population studied and the diagnostic test employed, prevalence may range from 2.4 to 21 per cent of all pregnancies[2,5]. In India it is difficult to predict any uniform prevalence levels because of wide differences in living conditions, socio-economic levels and dietary habits. Zargar *et al*[4] found the prevalence of GDM to be 3.8 per cent in Kashmiri women. In a random survey performed in various cities in India in 2002-2003, an overall GDM prevalence of 16.55 per cent was observed[3]. In another study done in Tamil Nadu, GDM was detected in 17.8 per cent women in urban, 13.8 per cent women in semi-urban and 9.9 per cent women in rural areas[5].

The data regarding prevalence of GDM and the number of women affected are important to allow for rational planning and allocation of resources and the preventive strategies that may be undertaken in future. Because widely different prevalence rates have been observed in studies in different regions of India, multiple regional studies in different subtypes of populations are needed for quantifying prevalence data as well as risk factors associated with it. The present study was, therefore, undertaken to study the prevalence of GDM in women attending a tertiary care hospital in Haryana and associated risk factors.

Material & Methods

This study was carried out during June 2009 to January 2011 in antenatal care clinic at Post Graduate Institute of Medical Sciences (PGIMS), Rohtak, Haryana. In an earlier study done at various centers across India the prevalence of gestational diabetes mellitus was found to be 16.55 per cent[3]. Assuming this prevalence with relative error of 20 per cent at level of significance of 95%, a sample of 500 eligible subjects was required. All pregnant women with estimated gestational age between 24th and 28th weeks attending ANC clinic during the study period were included in the study. All women were informed about the nature of study and those who consented were included in the study.The study protocol was approved by the institutional ethics committee. Women who were known diabetics, or who were suffering from any chronic illness were excluded from the study. A proforma containing general information on demographic characteristics, socio-economic status (according to Kuppuswami classification)[6], education level, parity, family history of diabetes and/or hypertension in first degree relatives and past history of GDM was filled up for each women. The women were advised to take their regular diet for three days and to come to ANC clinic after observing overnight fast (at least 8 h but not more than 14 h) for oral glucose tolerance test (OGTT). After estimating fasting capillary glucose all participants were subjected to OGTT with 75g anhydrous glucose powder dissolved in 250-300 ml water to be consumed within five minutes. Time was counted from the start of the drink. Fasting, 1 and 2 h post-glucose (FPG & PG) load, plasma glucose levels were estimated by glucometer (Ultra 2; Johnson and Johnson, New Brunswick, NJ), which was validated. In every tenth case venous plasma glucose was estimated by using glucose oxidase method[7]. The correlation coefficients for FPG, 1 and 2 h PG by glucometer and laboratory method were 0.96, 0.91 and 0.87. While waiting after the intake of 75 g glucose, the women were asked to avoid physical activity during the next 2 h. Anthropometry (weight, height, BP, *etc.*) was done after OGTT. BMI was calculated based on reported pre-pregnancy weight of the participant.

According to diagnostic criteria recommended by the American Diabetes Association (ADA) for a 2-h 75g OGTT, GDM is diagnosed if two or more plasma glucose levels meet or exceed the following thresholds, fasting glucose concentration of 95 mg/dl, 1-h glucose concentration of 180 mg/dl, and 2-h glucose concentration of 155 mg/dl[1].

Statistical analysis: Chi-square test was used to test the difference between two proportions. Odds ratios were calculated for different risk factors using bivariate and multiple logistic regression analyses. All statistical analyses were performed using SPSS version 17.0 software (SPSS Inc. Chicago IL).

Results

A total of 607 women were enrolled during the study period and their baseline characteristics are shown in Table I. GDM was diagnosed in 43 (7.1%) women based on ADA criteria. Of these, 17 women had all three values abnormal on OGTT and 26 women had two abnormal values. A single abnormal value was observed in 66 (10.87%) women, in whom fasting plasma glucose was the most common abnormal value seen in 55 women.

Most of the participants were below 26 yr of age (463, 76.3%) and highest number of participants were

in the age group 21-25 yr (353, 58.2%). The mean age of participants was 23.62 ± 3.42 yr (range 18-38). The prevalence rate was higher in women aged 26-30 and >30 yr (11.57 and 34.8%, respectively) compared to women aged 16-20 and 21-25 yr (4.54 and 4.53%, respectively) and this observation was found to be statistically significant (P<0.001).

Table I. Baseline characteristics of the study population

Characteristics	
Age (yr)	Number of participants (%)
16-20	110 (18.1)
21-25	353 (58.2)
26-30	121 (19.9)
>30	23 (3.8)
BMI (kg/m^2)	
<18.5	232 (38.2)
18.5-24.9	325 (53.6)
≥25	50 (8.2)
Parity	
0	254 (41.8)
1	245 (40.4)
2	73 (12.0)
>3	35 (5.8)
Education	
Professional/ Postgraduate/ Graduate	133 (21.9)
Intermediate/ High school/ Middle school	372 (61.3)
Primary school	72 (11.9)
Illiterate	30 (4.9)
Class	
Upper class	20 (3.3)
Upper middle	119 (19.6)
Lower middle	229 (37.7)
Upper lower	238 (39.2)
Lower	1 (0.2)

GDM rate increased with increasing educational qualification of the participants with highest being in women (19/133) who were graduate or above (14.3%). Only 7/30 (3.3%) illiterate women and 2/72 (2.8%) with primary school education had GDM. This observation was found to be statistically significant (P=0.003).

The prevalence of GDM was found to be higher in women belonging to upper and upper middle class (5/20, 25% and 20/119, 16.8%, respectively) and it was statistically significant (P<0.001) as compared to women belonging to lower middle class 10/219 (4.6%) and upper lower class 8/230 (3.4%). The mean age and BMI of women in upper class were significantly higher (P<0.01, <0.001, respectively) as compared to other socio-economic classes (Table II).

A significant association was found between prevalence of GDM and increasing BMI of participants (P<0.001). Women having BMI >25 kg/m^2 had GDM 11/50 (22%) compared to 11/232 (4.7%) in women with BMI <18.5 kg/m^2. Ten of 60 (16.7%) women with pre-pregnancy weight above 60 kg were found to have GDM compared to 14/157 (8.9%) in women with weight between 51 and 60 kg, 16/291 (5.5%) in women with weight between 41 and 50 kg and only 3/99 (3%) in women with weight less than or equal to 40 kg. This trend of increasing prevalence with increasing pre-pregnancy weight was found to be statistically significant (P=0.005).

Women diagnosed to have GDM had significant higher weight gain compared to non-GDM women. 11/43 (25.6%) of GDM women had weight gain of 7-10 kg in comparison to 11.7 per cent of non-GDM women (P<0.05). Also, the mean weight gain in GDM women was higher than non-GDM women (5.44 ± 1.86 compared to 4.52 ± 1.58 kg) and this was statistically significant (P<0.001).

Table II. Comparison of mean age and BMI of participants based on socio-economic status

Socio-economic class (n)	Mean age ± SD* (yr)	Mean BMI ± SD** (kg/m^2)
Upper class (20)	26.90 ± 4.712	22.374 ± 2.700
Upper middle (119)	24.63 ± 3.668	20.932 ± 3.734
Lower middle (229)	23.24 ± 3.158	20.057 ± 3.180
Upper lower (238)	23.21 ± 3.155	19.275 ± 2.834
Lower (1)	20.00 ± 0.000	16.866 ± 0.000

*P=0.018, **P=0.000

Acanthosis nigricans was present in 75 (12.4%) women. 20/43 (46.5%) women with GDM had acanthosis nigricans compared to 55/564 (9.8%) of the women without GDM. There was a significant association of acanthosis nigricans with GDM (P<0.001).

Fifty (8.24%) women had family history of diabetes mellitus, 7/43 (16.3%) women with GDM had positive family history compared to 43/564 (7.6%) women without GDM. This association was found to be significant (P<0.05). Of the total 36 (5.93%) women with family history of hypertension, six were found to have GDM. A positive family history of hypertension was more common in women with GDM (14%) than in women without GDM (5.3%). This association was found to be significant (P<0.05). Family history of both DM and hypertension was present only in eight women. No significant association was observed between family history of DM and hypertension with GDM. History of GDM in previous pregnancy was present in three women only and two of these developed GDM again. This association of history of GDM in previous pregnancy with GDM in index pregnancy was found to be significant (P<0.001).

Using bivariate analysis odds ratios were calculated for risk factors found to be positively associated with GDM (Table III). The odds ratio was highest for past history of GDM (27.46), followed by acanthosis nigricans (8.05) and socio-economic status >upper middle class (5.48). On multiple logistic regression analysis, only upper middle class and acanthosis nigricans were found to be significant risk factors for GDM (Table IV).

Discussion

In India, in a study done in 1982[8] the prevalence of GDM was found to be 2 per cent followed by 7.62 per cent in 1991[9] in another study. GDM was reported to be 6.7 per cent in rural women of Jammu district[10]. In a random survey performed in various cities in India in 2002-2003, the prevalence of GDM was 16.2 per cent in Chennai, 15 per cent in Thiruvananthapuram, 21 per cent in Alwaye, 12 per cent in Bangalore, 18.8 per cent in Erode and 17.5 per cent in Ludhiana[3]. An overall GDM prevalence of 16.55 per cent was observed. In another study done in Tamil Nadu (2005-2007), a total of 4151, 3960 and 3945 pregnant women were screened in urban, semi-urban and rural areas, respectively and GDM was detected in 17.8, 13.8 and 9.9 per cent women, respectively[5]. In a study done at a tertiary care hospital in Maharashtra the prevalence of GDM was found to be 7.7 per cent and 13.9 per cent women were found to have a single abnormal value on OGTT[11]. Use of different criteria for diagnosis of GDM may be responsible for different prevalence rates of GDM.

In our study 43 (7.1%) women were found to have gestational diabetes mellitus. None of them was a known case of diabetes. An additional 66 (10.87%) women had a single abnormal value on 2-h OGTT. Of these 66 women, 55 (83.33%) had abnormal fasting plasma glucose value. The mean fasting plasma glucose values of women with GDM was 103.85 ± 14.93 mg/dl compared to 86.22 ± 6.70 mg/dl in normal women (P<0.001). The prevalence of GDM in our study was similar to that reported by Swami *et al*[11] in Maharashtra (7.7%), using the ADA criteria. The Brazilian Gestational Diabetes Study evaluated the ADA and

Table III. Odds ratio for risk factors found to be associated with GDM (based on bi-variate analysis)

	Number with the condition (%)	Odds ratio	95% CI for OR		*P* value
			Lower	Upper	
Age >25 yr	144 (23.72)	3.795	2.020	7.131	<0.001
BMI >25 kg/m^2	50 (8.24)	4.627	2.168	9.878	<0.001
Family history of DM	50 (8.24)	2.356	0.990	5.608	<0.05
Family history of HTN	36 (5.93)	2.886	1.130	7.372	<0.05
Past history of GDM	3 (0.49)	27.463	2.439	309.252	<0.001
Socio-economic status ≥ upper middle class	139 (22.89)	5.482	2.892	10.395	<0.001
Weight gain >7 kg	77 (12.68)	2.594	1.248	5.391	<0.008
Acanthosis nigricans	75 (12.36)	8.047	4.157	15.581	<0.001
Educational status > graduate	133 (21.9)	3.125	1.654	5.903	<0.001

Table IV. Odds ratio for risk factors found to be associated with GDM (based on multiple logistic regression analysis)

	Number with the condition (%)	Odds ratio	95% CI for OR		*P* value
			Lower	Upper	
Socio-economic status > upper middle class	139 (22.89)	4.579	2.316	9.050	<0.001
Acanthosis nigricans	75(12.36%)	7.291	3.629	14.648	<0.001

World Health Organization (WHO) diagnostic criteria against pregnancy outcomes in an observational study of nearly 5000 women[2]. Using the 2-h 75 g OGTT criteria proposed by the ADA, the incidence of GDM was 2.4 per cent and it was 7.2 per cent using the WHO criteria.This study concluded that, although the WHO criteria identified more cases of GDM, both the ADA and WHO criteria are valid options for the diagnosis of GDM and the prediction of adverse pregnancy outcomes[2].

GDM showed an association with increasing age, higher parity, higher pre-pregnancy weight and BMI, history of diabetes in first degree relatives, past history of gestational diabetes in various studies[3-5,12-16]. In the present study, GDM was found to be associated with increasing age, higher educational level and socio-economic status, higher pre-pregnancy weight and BMI, higher weight gain during pregnancy, acanthosis nigricans, family history of diabetes or hypertension and past history of GDM.

In our study, prevalence of GDM increased significantly with increasing age. A similar association has been seen in earlier studies[4,5,11,13]. In our study the odds of a woman >25 yr developing GDM were 3.8 times than a woman <25 yr of age. Seshiah *et al*[5] reported an odds ratio of 2.1 for women ≥25 yr of age.

A significantly higher prevalence of GDM was observed with increasing educational level. This could be because of higher age of these women. Innes *et al*[17] had found an inverse association between the educational level of the pregnant woman and gestational diabetes mellitus. In another study carried out in Italy high levels of maternal education were found to be associated with reduced risks of GDM, compared to less educated women[18]. Yang *et al*[19] did not find an association between GDM and education in Chinese pregnant women.

A significant association of gestational diabetes mellitus was seen with socio-economic status of the participants. This association could be related to multiple factors such as higher maternal age, higher pre-pregnancy weight and BMI, more sedentary lifestyle in women of higher socio-economic status. Yang *et al*[19] did not find such an association in Chinese pregnant women while Keshavarz *et al*[20] found an association between GDM with low socio-economic level in pregnant Iranian women[18].

Obesity is an important risk factor in the development of GDM[5,14]. In our study GDM was found to be significantly higher in women with higher BMI and higher pre-pregnancy weight. Higher prevalence of GDM in women with higher BMI has also been observed in earlier studies as well[5,11,14]. Normal weight gain during pregnancy is 6 kg by the end of second trimester[21]. In our study, women with GDM had a significantly higher gain in weight compared to women without GDM. Saldana *et al*[22] observed that weight gain was significantly higher in women with gestational diabetes than in those with normal blood glucose. Bo *et al*[23] had observed that hyperglycaemia in pregnancy was a risk factor for excess gestational weight gain.

Higher parity has been found to be associated with higher prevalence of GDM in a few studies[3,4]. In our study, this association was not found to be statistically significant. Jang *et al*[24] found greater ratio of women with GDM in the group with parity >2, in comparison to primiparas but after controlling for age, pre-pregnancy BMI, height, family history of diabetes mellitus and weight gain during pregnancy, the results were not statistically significant.

It was observed in our study that acanthosis nigricans was significantly more common in women with GDM. Acanthosis nigricans is a marker of insulin resistance but may be confused with skin pigmentation, including that altered by pregnancy[25,26]. An association with GDM suggests a component of insulin resistance in development of GDM as has been observed in other studies[25,26].

Family history of diabetes mellitus has been reported to be associated with higher chances of developing GDM[4,5,11,15]. In our study, a significantly higher per cent of women with GDM had positive family history of diabetes mellitus. Seshiah *et al*[5] observed a significant association between the family

history of diabetes mellitus and the occurrence of GDM among pregnant women.

A significant association between history of GDM in previous pregnancy and development of GDM in the index pregnancy was seen, though the number of women with past history of GDM was small. The odds ratio was found to be 27.46. McGuire *et al*[16] observed an odds ratio of 23 for women with prior GDM.

To conclude, the present study reports 7.1 per cent prevalence of GDM from a tertiary care hospital of Haryana and highlights the importance of carrying out prevalence studies in different geographical regions of India to delineate the exact prevalence of GDM in the country.

References

1. American Diabetes Association. Gestational Diabetes Mellitus (Position Statement). *Diabetes Care* 2004; *27* (Suppl 2): S88-90.
2. Schmidt MI, Ducan BB, Reichelt AJ, Branchtein L, Matos MC, Costa e Forti A, *et al*. For the Brazilian Gestational Diabetes Study Group. Gestational diabetes mellitus diagnosed with a 2-h 75 gm oral glucose tolerance test and adverse pregnancy outcomes. *Diabetes Care* 2001; *24* : 1151-5.
3. Seshiah V, Balaji V, Balaji MS, Sanjeevi CB, Green A. Gestational diabetes mellitus in India. *J Assoc Physicians India* 2004; *52* : 707-11.
4. Zargar AH, Sheikh MI, Bashir MI, Masoodi SR, Laway BA, Wani AI, *et al*. Prevalence of gestational diabetes mellitus in Kashmiri women from the Indian Subcontinent. *Diabetes Res Clin Pract* 2004; *66* : 139-45.
5. Seshiah V, Balaji V, Balaji MS, Paneerselvam A, Arthi T, Thamizharasi M, *et al*. Prevalence of gestational diabetes mellitus in South India (Tamil Nadu) - a community based study. *J Assoc Physicians India* 2008; *56* : 329-33.
6. Mishra D, Singh HP. Kuppuswamy's socio-economic status scale - A revision. *Indian J Pediatr* 2003; *70* : 273-4.
7. Meites S, Banrey KS. Modified glucose oxidase method for determination of glucose in whole blood. *Clin Chem* 1973; *19* : 308-11.
8. Agarwal S, Gupta AN. Gestational Diabetes. *J Assoc Physicians India* 1982; *30* : 203-5.
9. Narendra J, Munichoodappa C, Gurudas A, Ramprasad AV, Madhav T, Vijayalakshmi, *et al*. Prevalence of glucose intolerance during pregnancy. *Int J Diab Dev Countries* 1991; *11* : 2-4.
10. Verma AK, Singh B, Mengi V. Gestational diabetes in rural women of Jammu. *Indian J Comm Med* 2008; *33* : 54-5.
11. Swami SR, Mehetre R, Shivane V, Bandgar TR, Menon PS, Shah NS. Prevalence of carbohydrate intolerance of varying degrees in pregnant females in western India (Maharashtra) - A hospital-based study. *J Indian Med Assoc* 2008; *106* : 712-4.
12. Metzger BE, Buchanan TA, Coustan DR, Levia AD, Dunger DB, Hadden DR, *et al*. Summary and recommendations of the Fifth International Workshop-Conference on Gestational Diabetes Mellitus. *Diabetes Care* 2007; *30* : S251-60.
13. Xiong X, Saunders LD, Wang FL, Demanczuk NN. Gestational diabetes: prevalence, risk factors, maternal and infant outcomes. *Int J Gynaecol Obstet* 2001; *75* : 221-8.
14. Torloni MR, Betran AP, Horta BL, Nakamura MU, Atallah AN, Moron AF, *et al*. Prepregnancy BMI and the risk of gestational diabetes: a systematic review of the literature with meta-analysis. *Obes Rev* 2009; *10* : 194-203.
15. Kim C, Liu T, Valdez R, Beckles GL. Does frank diabetes in first degree relatives of a pregnant woman affect the likelihood of her developing gestational diabetes mellitus or nongestational diabetes? *Am J Obstet Gynecol* 2009; *201* : 576, e1-6.
16. McGuire V, Rauh MJ, Mueller BA, Hickock D. The risk of diabetes in a subsequent pregnancy associated with prior history of gestational diabetes or a macrosomic infant. *Paediatr Perinat Epidemiol* 1996; *10* : 64-72.
17. Innes KE, Byers TE, Marshall JA, Baron A, Orleans M, Hamman RF. Association of a woman's own birth weight with subsequent risk for gestational diabetes. *JAMA* 2002; *287* : 2534-41.
18. Bo S, Marchisio B, Volpiano M, Menato G, Pagano G. Maternal low birth weight and gestational hyperglycemia. *Gynecol Endocrinol* 2003; *17* : 133-6.
19. Yang X, Hsu-Hage B, Zhang H, Yu L, Dong L, Li J, *et al*. Gestational diabetes mellitus in women of single gravidity in Tianjin City, China. *Diabetes Care* 2002; *25* : 847-51.
20. Keshavarz M, Cheung NW, Babaee GR, Moghadam HK, Ajami ME, Shariati M. Gestational diabetes in Iran: incidence, risk factors and pregnancy outcomes. *Diabetes Res Clin Pract* 2005; *69* : 279-86.
21. Physiological changes during pregnancy, In: Dutta DC. *Textbook of obstetrics*, 6th ed. New Central Book Agency (P) Ltd.; 2004. p. 50.
22. Saldana TM, Siega-Riz AM, Adair LS, Suchindran C. The relationship between pregnancy weight gain and glucose tolerance status among black and white women in central North Carolina. *Am J Obstet Gynecol* 2006; *195* : 1629-35.
23. Bo S, Menato G, Signorile A, Bardelli C, Lezo A, Gallo ML, *et al*. Obesity or diabetes: what is worse for the mother and for the baby? *Diabetes Metab* 2003; *29* : 175-8.
24. Jang HC, Min HK, Lee HK, Cho NH, Metzger BE. Short stature in Korean women: a contribution to the multifactorial predisposition to gestational diabetes mellitus. *Diabetologia* 1998; *41* : 778-83.
25. Lopez-Alvarenga JC, Garcia-Hidalgo L, Landa-Anell MV, Santos-Gomez R, Gonzalez-Barranco J, Comuzzie A. Influence of skin color on the diagnostic utility of clinical acanthosis nigricans to predict insulin resistance in obese patients. *Arch Med Res* 2006; *37* : 744-8.
26. Muallem MM, Rubeiz NG. Physiological and biological skin changes in pregnancy. *Clin Dermatol* 2006; *24* : 80-3.

Reprint requests: Dr Rajesh Rajput, Senior Professor & Head, Department of Medicine VII & Endocrinology
Post Graduate Institute of Medical Sciences, Rohtak 124 001, Haryana, India
e-mail: rajputrajmeena@hotmail.com