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*Original Article*

# Gestational Diabetes Mellitus and Associated Risk Factors in Patients Attending Diabetic Association Medical College Hospital in Faridpur

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### *Abstract*

***Background***: *The prevalence of gestational diabetes mellitus (GDM) is increasing all over the world and varies widely depending on the region of the country, dietary habits and socio-economic status. The prevalence of GDM with its associated risk factors has important health complications for both mother and child.* ***Objectives***: *The aim of this study was to evaluate the prevalence of GDM and risk factors associated with it in women attending Diabetic Association Medical College Hospital in Faridpur for ante-natal care.* ***Materials and Methods***: *In this cross-sectional study, screening for GDM was performed in 303 pregnant women. Women who consented to participate underwent a standardized 2-hour 75 gm oral glucose tolerance test (OGTT). A proforma containing general information on demographic characteristics, socio-economic status, education level, parity, family history of diabetes and past history of GDM etc. was filled in. American Diabetes Association (ADA) criteria for 75 gm 2-hour OGTT was used for diagnosing GDM.* ***Results***: *A total of 303 women participated in the study and GDM was diagnosed in 22 (7.3%) women. A single abnormal value was observed in additional 33 (10.89%) women. On bivariate analysis risk factors found to be significantly associated with GDM were age, household income, parity, educational level, socio-economic status, hypertension, BMI, weight gain, acanthosis nigricans, family history of diabetes 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.* ***Conclusion***: *This study demonstrates a high prevalence of GDM in Bangladesh. These estimates for GDM may help for new suggestions to prevent and manage gestational diabetes.*

***Key words***: *Gestational diabetes mellitus; OGTT; Prevalence; Associated risk factors*

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## Introduction

The prevalence of diabetes mellitus (DM) is increasing worldwide and more in developing countries including Bangladesh. The increasing prevalence in developing countries is related to increasing urbanization, decreasing 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 carbohydrate intolerance of variable severity, with an onset or first recognition during pregnancy.[6,7] It represents the most common metabolic complication of pregnancy and is associated with maternal morbidity (hypertension, pre-eclampsia, cesarean section, infection, polyhydramnios) as well as fetal morbidity (macrosomia, birth trauma, hypoglycemia, hypocalcemia, hypomagnesemia, hyperbilirubinemia, respiratory distress syndrome,

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polycythemia).[8-11] Moreover, women with GDM have a considerably increased risk for impaired glucose tolerance (IGT) and type 2 diabetes in the years following pregnancy.[11,12] Women with GDM are up to six times more likely to develop type 2 diabetes than women with normal glucose tolerance in pregnancy.[13,14] Children of women with GDM are more likely to be obese and have IGT (impaired glucose tolerance) and diabetes in childhood and early adulthood.[15]

The prevalence of GDM, as reported in different studies, varies between 1% and 14% in all pregnancies depending on the genetic characteristics and environment of the population under study, screening and diagnostic methods employed as well as on prevalence of type 2 diabetes mellitus.[16,17] The traditional and most often reported risk factors for GDM are older age (high maternal age), pre-pregnancy obesity, high parity, family history of diabetes (especially in first-degree relatives), previous delivery of a macrosomic infant and previous obstetric outcome history (e.g., previous history of GDM, congenital malformation, cesarean section).[18-20]

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. The present study was, therefore, undertaken to study the prevalence of GDM and associated risk factors in women attending Diabetic Association Medical College Hospital, Faridpur, Bangladesh.

## Materials and Methods

This study was carried out during July 2015 to June 2016 in Diabetic Association Medical College Hospital, Faridpur during antenatal care. In the present study 303 pregnant women were included. At the first prenatal visit, anthropometric and demographic data for all pregnant women included in the study were obtained by educated surveyors using a structured questionnaire. Pregnant women responded to a structured questionnaire including age, level of education, occupation, monthly household income, their obstetric history, weight gain during pregnancy (<7 kg and ≥7 kg), family history of diabetes in first degree relatives, parity, number of pregnancies, and history of GDM in previous pregnancies. After questioning about risk factors for GDM, physical examinations of the pregnant women were done. The measurements of arterial blood pressure, weight and height were recorded. Systolic and diastolic blood pressures (SBP and DBP) were measured three times in a sitting position after a 15-minute rest. SBP ≥140 mm Hg and DBP ≥90 mm Hg in pregnant women were accepted as hypertensive values. Participants were advised to avoid cigarette smoking, alcohol, caffeinated beverages, and exercise for at least 30 minutes before their blood pressure measurement. Each woman's pre-pregnancy body mass index (BMI) was calculated from the last height and most recent weight before conception. BMI was calculated as weight (kilograms) divided by the square of height (meters squared). All subjects gave informed written consent prior to participation.

In this cross-sectional study, the women were advised to take regular diet for three days and to come to hospital after observing overnight fast (at least 8 hours but not more than 14 hours) for oral glucose tolerance test (OGTT). After estimating fasting capillary glucose all participants were subjected to OGTT with 75 gm 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-hour post-glucose (FPG and 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. The correlation coefficients for FPG, 1 and 2 hour PG by glucometer and laboratory method were 0.96, 0.91 and 0.87. While waiting after the intake of 75 gm glucose, the women were asked to avoid physical activity during the next 2 hours. According to diagnostic criteria recommended by the American Diabetes Association (ADA) for a 2-hour 75 gm OGTT, GDM was diagnosed if two or more plasma glucose levels met or exceeded the following thresholds: fasting glucose concentration of 95 mg/dL, 1-hour glucose concentration of 180 mg/dL, and 2-hour glucose concentration of 155 mg/dL.

### Statistical analysis

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

## Results

A total of 303 women were enrolled in the study and their baseline characteristics are shown in Table I. GDM was diagnosed in 22 (7.3%) women based on ADA criteria. A single abnormal value was observed in 33 (10.89%) women, in whom fasting plasma glucose was the most common abnormal value seen in 25 women.

The clinical and metabolic characteristics of subjects with GDM and without GDM included in the study are given in Table I. The mean age, education, BMI, parity, pre-pregnancy weight, weight during pregnancy, weight gain during pregnancy and blood pressure were found to be higher in pregnant women with GDM than in pregnant women without GDM.

Table I shows baseline characteristics of the study population. The mean age of participants was 23.62 ± 3.42 years (range 18−38). Most of the participants were below 26 years of age and highest number of participants was in the age group 21−25 years. In this age group non-GDM was 160 (94.7%) and GDM 9 (5.3%). In women aged 26−30 years, prevalence rate of non-GDM was 85.1% and GDM was 14.9%. Prevalence of GDM increased with age, with the highest prevalence in the 26−30 years age group (45.5%) compared to women aged 16−20 years (GDM 4%) and 21−25 years (GDM 5.3%). In non-GDM group, highest number of subjects was in 21−25 years age group, but in GDM group highest number of subjects was in 26−30 years age group.

GDM rate increased with increasing educational qualification of the participants with highest being in women who were graduate or above (non-GDM 59, 84.3% and GDM 11, 15.7%). In illiterate group only one GDM case (6.7%) was found and non-GDM was 14 (93.3%). In women with primary school education we found three GDM cases (8.3%) and 33 non-GDM cases (91.7%). In women with secondary level education there were seven GDM cases (3.8%) and 175 non-GDM cases (96.2%).

The prevalence of GDM was found higher in women belonging to upper class (8/41, 19.5%) and upper middle class (7/123, 5.7%) and it was statistically significant ($p<0.001$) as compared to women belonging to lower middle class (6/115, 5.2%) and of lower class (1/24, 4.2%). The mean age and BMI of women in upper class were significantly higher ($p<0.01$, $p<0.001$ respectively) as compared to other socio-economic classes (Table II).

A significant association was found between prevalence of GDM and increasing BMI of participants ($p<0.001$). In women having BMI ≥25 kg/m$^2$ GDM was 20.7% (6/29) compared to in women with BMI <18.5 kg/m$^2$ 6.1% (7/115). Five out of 35 (14.3%) women with pre-pregnancy weight above 60 kg were found to have GDM compared to 7/85 (8.2%) in women with weight between 51 and 60 kg, 8/153 (5.2%) in women with weight between 41 and 50 kg and only 2/52 (3.8%) in women with weight less than or equal to 40 kg. This trend of increasing prevalence with increasing pre-pregnancy weight was found statistically significant ($p=0.005$).

Women with GDM had significant higher weight gain compared to non-GDM women. Twelve out of 22 (54.5%) of GDM women had weight gain of 7−10 kg in comparison to 45.9% 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 ($p<0.001$).

Forty five (16.0%) women in non-GDM group had family history of diabetes mellitus whereas 4 (18.2%) in GDM group had positive family history. This association was found significant ($p<0.05$). Family history of GDM was present only in 5 (1.7%) women. History of GDM in previous pregnancy was present in 4 (1.32%) women only and one of these developed GDM. This association of history of GDM in previous pregnancy with GDM in index pregnancy was found to be significant ($p<0.001$).

Acanthosis nigricans was present in 18 (5.9%) women (Table III) — 4 (18.2%) in GDM women and 14 (5.0%) in non-GDM women. There was a significant association of acanthosis nigricans with GDM ($p<0.001$).

Table I: Baseline characteristics of the study population (N=303)

| Parameters | Non-GDM Number (%) | GDM Number (%) |
|---|---|---|
| ***Age (years)*** | | |
| 16−20 | 55 (19.6) | 1 (4.5) |
| 21−25 | 160 (56.9) | 9 (40.9) |
| 26−30 | 57 (20.3) | 10 (45.5) |
| >30 | 9 (3.2) | 2 (9.1) |
| Total | 281 (100) | 22 (100) |

| | | |
|---|---|---|
| *Level of education* | | |
| Illiterate | 14 (5.0) | 1 (4.6) |
| Primary | 33 (11.7) | 3 (13.6) |
| Secondary | 175 (62.3) | 7 (31.8) |
| Graduate | 59 (21.0) | 11(50) |
| Total | 281 (100) | 22 (100) |
| *Occupation* | | |
| Housewife | 181 (64.4) | 16 (72.7) |
| Official | 19 (6.8) | 2 (9.1) |
| Worker | 81 (28.8) | 4 (18.2) |
| Total | 281 (100) | 22 (100) |
| *Socio-economic status* | | |
| Upper class | 33 (11.7) | 8 (36.4) |
| Upper middle | 116 (41.3) | 7 (31.8) |
| Lower middle | 109 (38.8) | 6 (27.3) |
| Lower | 23 (8.2) | 1 (4.5) |
| Total | 281 (100) | 22 (100) |
| *Pregnancy BMI (kg/m2)* | | |
| <18.5 | 108 (38.4) | 7 (31.8) |
| 18.5−24.9 | 151 (53.7) | 9 (40.9) |
| ≥25 | 23 (8.2) | 6 (27.3) |
| Total | 281 (100.3) | 22 (100) |
| *Parity* | | |
| 0 | 117 (41.6) | 8 (36.4) |
| 1 | 113 (40.2) | 9 (40.9) |
| 2 | 34 (12.1) | 2 (9.1) |
| >3 | 17 (6.1) | 3 (13.6) |
| Total | 281 (100) | 22 (100) |
| *Weight gain during pregnancy* | | |
| <7 kg | 152 (54.1) | 10 (45.5) |
| ≥7 kg | 129 (45.9) | 12 (54.5) |
| Total | 281 (100) | 22 (100) |
| *Height* | | |
| <155 cm | 92 (32.8) | 7 (31.8) |
| 155−170 cm | 172 (61.2) | 13 (59.1) |
| >170 cm | 17 (6.0) | 2 (9.1) |
| Total | 281 (100) | 22 (100) |
| *Weight* | | |
| ≤40 kg | 46 (16.4) | 2 (9.1) |
| 41−50 kg | 135 (48.0) | 8 (36.4) |
| 51−60 kg | 73 (26.0) | 7 (31.8) |
| >60 kg | 27 (9.6) | 5 (22.7) |
| Total | 281 (100) | 22 (100) |
| *Significant past medical history* | | |
| None | 268 (95.4) | 21 (95.5) |
| Hypertension | 10 (3.6) | 1 (4.5) |
| Dyslipidemia | 1 (0.3) | 0 |
| Heart failure | 2 (0.7) | 0 |
| Total | 281 (100) | 22 (100) |
| *Previous history of GDM* | | |
| None | 278 (98.9) | 21 (95.5) |
| Yes | 3 (1.1) | 1 (4.5) |
| Total | 281 (100) | 22 (100) |
| *Family history of diabetes* | | |
| None | 236 (84.0) | 18 (81.8) |
| First degree relatives | 22 (7.8) | 3 (13.6) |
| Other relatives | 23 (8.2) | 1 (4.6) |
| Total | 281 (100) | 22 (100) |
| *Family history of GDM* | | |
| None | 277 (98.6) | 21 (95.5) |
| Yes | 4 (1.4) | 1 (4.5) |
| Total | 281 (100) | 22 (100) |
| *SBP (mm of Hg)* | | |
| <100 | 69 (24.5) | 5 (22.7) |
| 100−119 | 98 (34.9) | 7 (31.8) |
| 120−140 | 102 (36.3) | 8 (36.4) |
| ≥140 | 12 (4.3) | 2 (9.1) |
| Total | 281 (100) | 22 (100) |
| *DBP (mm of Hg)* | | |
| <80 | 23 (8.2) | 3 (13.6) |
| 80−89 | 244 (86.8) | 17 (77.3) |
| ≥90 | 14 (5.0) | 2 (9.1) |
| Total | 281 (100) | 22 (100) |

Table II: Comparison of mean age and BMI of participants based on socio-economic status (N=303)

| Socio-economic class | Mean age (years) | Mean BMI (kg/m2) |
|---|---|---|
| Upper class (n=41) | 26.90 ± 4.712 | 22.374 ± 2.700 |
| Upper middle (n=123) | 24.63 ± 3.668 | 20.932 ± 3.734 |
| Lower middle (n=115) | 23.24 ± 3.155 | 20.057 ± 3.180 |
| Lower (n=24) | 20.00 ± 2.143 | 16.866 ± 2.312 |

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

| Condition | Number (%) | Odds ratio | 95% CI for OR Lower−Upper | p values |
|---|---|---|---|---|
| Age >25 years | 78 (25.74) | 3.795 | 2.020−7.131 | <0.001 |
| BMI >25 kg/m$^2$ | 29 (9.57) | 4.627 | 2.168−9.878 | <0.001 |
| Family history of DM | 49 (16.17) | 2.356 | 0.990−5.608 | <0.05 |
| Past history of GDM | 4 (1.32) | 27.463 | 2.130−309.252 | <0.001 |
| Upper & middle class | 164 (54.13) | 5.482 | 2.439−10.395 | <0.001 |
| Weight gain >7 kg | 141 (46.53) | 2.594 | 1.248−5.391 | <0.008 |
| Acanthosis nigricans | 18 (5.9) | 8.047 | 4.157−15.581 | <0.001 |
| Educational status above graduation | 70 (23.10) | 3.125 | 1.654−5.903 | <0.001 |

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

| Condition | Number (%) | Odds ratio | 95% CI for OR | p values |
|---|---|---|---|---|
| Socio-economic status upper & middle class | 164 (54.13) | 4.579 | 2.316−9.050 | <0.001 |
| Acanthosis nigricans | 18 (5.9) | 7.291 | 3.629−14.648 | <0.001 |

Using bivariate analysis odds ratios were calculated for risk factors and were found 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 of upper and middle class (5.48). On multiple logistic regression analysis, only upper middle class and acanthosis nigricans were found as significant risk factors for GDM (Table IV).

## Discussion

In Bangladesh, the prevalence of GDM was found 9.7% in a study done in 2014 according to WHO criteria and 12.9% according to the ADA criteria and the prevalence of overt diabetes was 1.8% according to ADA criteria.[21] It is lower than a Middle Eastern study from Qatar (16.3%) and the United Arab Emirates (20.6%), but higher than Iran (4.8%) and Turkmenistan (6.3%).[22] Overall prevalence of GDM varies from 4−6% in USA and 2–6% in European countries. Thus, prevalence of GDM seems greater in developing countries from Asians. However, it is important to note that the prevalence of GDM varies widely according to the specific cut-off points used in the various studies. The variation may be also due to time lag, specific study subject, environmental diversity, dietary habits, and other national or sub-national socio-behavioral factors. It is also difficult to compare disease prevalence, particularly for diabetes, with results from older literature because of the rapid epidemiologic and demographic transitions occurring in most developing countries.

In our study 22 (7.3%) women were found to have gestational diabetes mellitus. None of them was a known case of diabetes. An additional 33 (10.89%) women had a single abnormal value on 2-hour OGTT. Of these 33 women, 25 (75.76%) 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[23] in Maharashtra (7.7%), using the ADA criteria. The Brazilian Gestational Diabetes Study evaluated the ADA and World Health Organization (WHO) diagnostic criteria against pregnancy outcomes in an observational study on nearly 5000 women. Using the 2-hour 75 gm OGTT criteria proposed by the ADA, the incidence of GDM was 2.4% and it was 7.2% 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.

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.[24,25] In the present study, GDM was found to be associated with increasing age, higher educational level and socio-economic status, higher pre-pregnancy weight, 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. In this study the odds of a woman >25 years developing GDM were 3.8 times than a woman <25 years of age. Seshiah et al[26] reported an odds ratio of 2.1 for women >25 years 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[27] had found an inverse association of the educational level of the pregnant woman with 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. Yang et al[28] 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[28] did not find such an association in Chinese pregnant women while Keshavarz et al[29] found an association of GDM with low socio-economic level in pregnant Iranian women.

Obesity is an important risk factor in the development of GDM. In our study GDM was found to be significantly higher in women with higher BMI and higher pre-pregnancy weight. Normal weight gain during pregnancy is 6 kg by the end of second trimester. In our study, women with GDM had a significantly higher gain in weight compared to women without GDM. Saldana et al[30] observed that weight gain was significantly higher in women with gestational diabetes than in those with normal blood glucose. Bo et al[31] had observed that hyperglycemia in pregnancy was a risk factor for excess gestational weight gain.

Higher parity has been found associated with higher prevalence of GDM in a few studies. Jang et al[32] 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.

Family history of diabetes mellitus has been reported to be associated with higher chances of developing GDM. In our study, a significantly higher percent of women with GDM had positive family history of diabetes mellitus. Seshiah et al[26] 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 27.46.

The main disadvantage of the present study is that it is a local, regional study. Therefore, the number of participants was low. In addition, we could not use other diagnostic criteria for GDM. Therefore, different GDM screening methods could not be compared with each other.

The present study reports 7.3% prevalence of GDM from Diabetic Association Medical College Hospital, Faridpur. This study shows a relatively high prevalence of GDM in Bangladeshi women and suggests that screening for glucose intolerance in pregnancy should be considered as part of routine antenatal care. As it is a small scale and institutional study, it does not represent the actual condition of our women who suffers from GDM in our country. Further studies with large sample size covering both urban and rural population will give more information about GDM. However, this information is effective for targeted preventive approaches for complications associated with GDM in both the mothers and their offsprings and to formulate new policies or strategies to increase awareness, prevention, and management of diabetes among pregnant women in Bangladesh.

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