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Indian Journal of Obstetrics and Gynecology Research

Journal homepage: www.ijogr.org

Original Research Article

Factors associated with gestational diabetes mellitus: A case control study in a tertiary care hospital in Kolkata, West Bengal

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Abstract

Background: Gestational Diabetes Mellitus (GDM) is a significant public health concern, particularly in developing countries like India, where its prevalence is rising. This study aimed to identify the modifiable and non-modifiable risk factors associated with GDM among pregnant women attending a tertiary care hospital in Kolkata, West Bengal.

Materials and Methods: A case-control study was conducted over 17 months, involving 113 cases (pregnant women diagnosed with GDM) and 226 controls (pregnant women without GDM). Data were collected through structured interviews, medical records, and physical measurements. The association between various risk factors and GDM was analysed using bivariate and multivariate statistical methods.

Results: Significant risk factors for GDM in univariate analysis included a family history of diabetes (OR 1.86, 95% CI: 1.25-2.78), hypertension (OR 2.67, 95% CI: 2.00-3.58), previous history of GDM (OR 20.19, 95% CI: 5.64-72.21), and polycystic ovarian syndrome (PCOS) (OR 5.53, 95% CI: 0.99-30.94). Modifiable factors such as weight gain ≥7 kg (OR 2.48, 95% CI: 1.556-3.974), low to moderate physical activity (OR 3.20, 95% CI: 1.14-0.68), multiparity (OR 4.53, 95% CL: 2.21-9.29) were also significantly associated with GDM using univariate regression analysis. However, applying proportional hazard model factors like family history of diabetes, previous history of GDM, History of abortion were only significant risk factors.

Conclusion: The present study emphasizes the need for early screening and timely intervention in pregnant women with identifiable risk factors such as a family history of diabetes or hypertension, previous history of GDM, and PCOS. Adopting lifestyle modifications, may play a significant role in reducing the risk of developing GDM.

Keywords: GDM, Pregnancy, Risk factors, Case control.

Received: 11-04-2025; **Accepted:** 18-08-2025; **Available Online**: 18-11-2025

1. Introduction

Gestational Diabetes Mellitus (GDM) is defined as hyperglycaemia due to abnormal glucose tolerance of variable severity diagnosed during pregnancy.[1] It is a significant public health concern for India where its prevalence is estimated to be 10-14.3%, which is significantly higher than in Western countries.[2] According to International Diabetes Federation (IDF) in 2017, that one in every seven live birth is affected by GDM. Adverse pregnancy outcomes due to GDM such as neonatal hypoglycaemia, macrosomia, increased risk of type 2 diabetes in both mother and child was reported to be present in 86.4% of cases.[3]

Several factors have been identified as a potential risk factors of Gestational Diabetes Mellitus (GDM), many of which also overlap with those for type 2 diabetes mellitus (T2DM). These include several modifiable as well as non-modifiable factors such as advanced maternal age, obesity and family history of T2DM. Also, a prior history of GDM, preeclampsia, pregnancy induced hypertension, intra uterine fetal death, macrosomia, polyhydramnios, preterm labor,

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https://doi.org/10.18231/j.ijogr.32592.1763459802

stillbirths, congenital anomalies in previous pregnancy has found to be increased risk of GDM in subsequent pregnancies. Given the potential to modify many of these risk factors, their early detection is crucial for timely intervention and improved maternal-fetal outcomes.[4] Rapid urbanization, decreased physical activity, along with sedentary lifestyle has led to a surge in overweight, further contributing to the rising incidence of GDM.[5-8]

Early detection of Gestational Diabetes Mellitus through glucose tolerance test between 24-28 weeks of pregnancy, combined with appropriate interventions such as dietary adjustments, regular physical activity, and appropriate treatment when required, can reduce perinatal complications. Given the growing burden of GDM and keeping in mind its probable long-term implications, acknowledging its risk factors, and tackling those through effective prevention strategies are of utmost importance, particularly in developing countries like India. Despite its burden, lack of statistical power in prior studies has resulted in inconclusive evidence on the determinants of GDM in developing countries. In this context this study aims to identify modifiable and non-modifiable risk factors associated with GDM in a high-risk Indian population, to support targeted interventions that can reduce the disease's impact on maternal and child health.

2. Materials and Methods

A case control study was conducted in the antenatal Clinic in a Medical College Hospital in Kolkata, West Bengal from June 2021 to October 2022.

The study population consisted of cases i.e. pregnant women diagnosed by expert obstetricians using clinical criteria and Laboratory parameters to have Gestational Diabetes Mellitus and Controls i.e Pregnant woman without Gestational Diabetes Mellitus, attended the antenatal clinic for the routine checkup.

Frequency matching was performed based on maternal age and gestational age. Exclusion criteria included women with pre-existing diabetes, those in active labor, and those with chronic illnesses such as tuberculosis, malignancy, renal failure, congestive heart failure, advanced liver failure, or mental retardation.

Considering 95% confidence level, 80% power, and prior data showing a 21.33% GDM prevalence among first-degree relatives (vs. 8.33% in controls),[9] the final sample size was 339, comprising 113 cases and 226 controls (1:2 ratio).

Systematic random sampling was used as sampling method. On average, six GDM patients visited the clinic daily. Every alternate patient was selected as a case over a 20-week period until the sample size was reached. For each case, two matched controls were selected using the same method.

The exposure variables of this study were sociodemographic characteristics, BMI at the diagnosis of GDM, factors associated till the GDM diagnosis, Dietary practice of the past seven days, physical activity of past seven days according to IPAQ questionnaire, Family H/O hypertension, Family H/O diabetes in 1st degree relatives, past H/O GDM, Obstetric history, H/O abortion, congenital anomaly, preterm delivery, intra uterine fetal death, macrosomia, polyhydramnios, pre-eclampsia, urinary tract infection, PCOS.

The outcome variable being presence of gestational diabetes mellitus. GDM was diagnosed using the DIPSI one-step method. A 75g oral glucose load was administered regardless of the time of the last meal, and plasma glucose was measured at 2 hours. A value ≥140 mg/dL indicated GDM.

Interview were done for both cases and controls in antenatal clinic of college of medicine and sagore dutta hospital, talking informed consent from the pregnant mothers and maintaining proper privacy after they were identified as cases and controls.

2.1. Study tools, techniques, and data collection

Participants were interviewed using a predesigned pretested schedule containing six sections.

1. First section meant to collect the socio demographic and individual characteristics of the participants
2. Menstrual and obstetric history related to current pregnancy containing parity, age at 1st pregnancy, weight gain from 1st trimester until the diagnosis.
3. Physical activity during pregnancy using IPAC Questionnaire 29.

Data regarding physical activity was obtained by administrating a standardized questionnaire– the long form of International Physical Activity Questionnaire-long form (IPAQ).[10] Data were collected reported in metabolic equivalent-minutes per week (MET-minutes/week). MET-minute/week then computed for each activity as follows:

MET-minutes/week = MET level × minutes of activity/ day × days/week.

The total scores were sub-categorized into three levels of physical activity:
High: Total physical activity ≥3000 MET-minutes/week.
Moderate: Total physical activity 600 to < 3000 MET Minutes/week.
Low: The total physical activity <600 MET minutes/week
IPAQ scale was translated from original English version into Bengali language. Translations and back translations were matched and finalized, pilot tested and validated.

1. Family history of diabetes and/or hypertension in first degree relatives and obstetric history of past pregnancy if any,

2. Structured format for review of records such as Past and present OPD tickets, past and present prescriptions (if any) to check the history of gestational diabetes mellitus, polyhydramnios, history of pre-eclampsia, abortion, intra uterine fetal death, laboratory reports and MCP cards.

Mothers were identified as cases after they are diagnosed as GDM in the antenatal clinic of G&O dept. The maternal heights were measured, weights noted from past records in the first trimester and their body mass index (BMI) were calculated.

2.2. Statistical analysis

Statistical analyses were performed using Statistical analyses were performed using Jamovi (The Jamovi Project, 2024) (Computer Software) solid version 2.3.28. Retrieved from https://www.jamovi.org, Sydney, Australia. Measure of central tendency and dispersion of quantitative data will be expressed with mean (±SD) and median (± IQR). The categorical data will be expressed in percentage. Bivariate nonparametric tests of significance (McNemar Chi sq test), Conditional logistic regression test was be applied to examine association between exposure variables and outcome variables.

2.3. Ethics

Apart from obtaining approval from IEC, COMSDH, (CMSDH/IEC/221/03-2021) written informed consent was obtained from each respondent using informed consent form prepared in their vernacular language before commencement of registration of responses. Anonymity of the participants and confidentiality of data were rigorously maintained. The research followed the Helsinki Declaration guidelines, updated in 2013.

3. Results

A total of 339 pregnant women participated in the study: 113 cases (GDM) and 226 matched controls (non-GDM). Among these, participants were selected using standardized diagnostic criteria based on DIPSI guidelines. The mean (±SD) age of the participants was 29.2 (± 4.6). The mean (±SD) gestational age at diagnosis for GDM cases was 26 weeks 3 days (±3 weeks 3 days), while controls were enrolled at an average gestational age of 26 weeks 2 days (±3 weeks 4 days). Majority of the study population, 74.3% cases and 85.8% controls reside in urban area, 25.7% of cases and 14.2% controls reside in rural area.

Baseline socio-demographic characteristics of the study participants are presented in **Table 1**. Among the modifiable risk factors, odds of low-to-moderate physical activity were significantly higher among GDM cases compared to controls (Crude OR: 0.31, 95% CI: 0.14–0.68, $p < 0.001$). Similarly, excessive gestational weight gain (≥7 kg) was observed in nearly half (49.6%) of the GDM cases, compared to only 28.3% of the controls (Crude OR: 2.48, 95% CI: 1.55–3.97, $p < 0.001$).

In terms of parity, 91.2% of cases were multiparous, as compared to 59.3% of controls. The odds of developing GDM were significantly higher among multiparous women (Crude OR: 4.53, 95% CI: 2.21–9.29, $p < 0.001$). Other modifiable factors such as education, occupation, and socioeconomic status did not show statistically significant associations.

Among non-modifiable factors (**Table 2**), a significantly greater proportion of GDM cases (38.9%) reported a positive parental history of diabetes mellitus compared to controls (16.4%) (Crude OR: 3.25, 95% CI: 1.94–5.46, $p < 0.001$). Similarly, 29.2% of cases reported diabetes in siblings versus 15% of controls (Crude OR: 2.32, 95% CI: 1.35–4.01, $p < 0.001$). Family history of hypertension was also more prevalent among cases (45.1%) than controls (26.5%) (Crude OR: 2.27, 95% CI: 1.41–3.65, $p < 0.001$).

Previous obstetric complications were notably more common among cases. History of GDM in a previous pregnancy was reported by 33.1% of cases compared to just 3.6% of controls (Crude OR: 13.22, 95% CI: 5.30–32.93, $p < 0.001$). History of abortion was present in 39.9% of cases versus 24% of controls (Crude OR: 2.09, 95% CI: 1.23–3.57, $p < 0.001$). Notably, 15.6% of cases reported polyhydramnios compared to 6.6% of controls (Crude OR: 2.60, 95% CI: 1.16–5.87, $p = 0.02$). Additionally, history of PCOS (15% vs. 2.2%) and preeclampsia (31.1% vs. 17.2%) were significantly associated with GDM (Crude OR: 8.0 and 2.97 respectively, both $p < 0.001$).

The conditional logistic regression model identified several independent risk factors for GDM (**Table 3**). After adjusting for potential confounders, the following were significantly associated with increased odds of GDM:

1. History of GDM in previous pregnancy (Adjusted OR: 28.38, 95% CI: 9.71–82.88, $p < 0.001$).
2. History of abortion (Adjusted OR: 6.58, 95% CI: 3.24–13.35, $p < 0.001$).
3. History of diabetes in parents (Adjusted OR: 5.24, 95% CI: 2.48–11.04, $p < 0.001$).
4. History of polycystic ovarian syndrome (Adjusted OR: 6.96, 95% CI: 2.04–23.74, $p = 0.05$).
5. Weight gain ≥7 kg till diagnosis (Adjusted OR: 1.6, 95% CI: 1.2–2.0, $p < 0.001$).

Although the history of diabetes in siblings and intrauterine fetal death showed near-significant trends ($p = 0.05$ and $p = 0.06$ respectively), they did not retain statistical significance in the adjusted model.

Table 1: Distribution of the study participants according to the modifiable factors

Variables	Cases	Controls	Odds ratio (95% CI)	p value
Age at 1st Pregnancy				
<18yrs	09(8.0)	21(9.3)	Ref	
18-25yrs	80(70.8)	128(56.6)	1.45(0.63-3.34)	0.37
26-30yrs	14(12.4)	46(20.4)	0.71(0.26-1.89)	0.49
>30yrs	10(8.8)	31(13.7)	0.750.26-2.16)	0.59
Parity				
Nullipara	10(8.8)	59(40.7)	Ref	
Multipara	103(91.2)	134(59.3)	4.53(2.21-9.29)	0.00
Education				
Illiterate and just literate	0	10(2.7)		
Upto Class 1-4	06(5.3)	12(5.3)	1.40(0.47-4.12)	0.53
Class 5-10	81(71.7)	135(59.7)	1.68(0.99-2.84)	0.05
School certificate and above	26(23.0)	73(32.3)	Ref	
Occupation				
Home maker	95(84.0)	203(89.9)	Ref	
Manual	04(3.6)	06(2.6)	1.42(0.39-5.16)	0.59
Non manual	14(12.4)	17(7.5)	1.75(0.83-3.71)	0.13
Socio-economic status				
Upper Class	0	7(3.1)	Ref	
Upper middle class	10(8.8)	34(15.0)	1.15(0.20-6.52)	0.86
Middle Class	46(40.7)	86(38.1)	1.06(0.18-6.06)	0.93
Lower Middle Class	55(48.7)	95(42.1)	0.58(0.09-3.69)	0.57
Lower Class	02(1.8)	04(1.7)		
Weight gain till GDM diagnosis				
<7kg	57(50.4)	162(71.7)	Ref	
>=7kg	56(49.6)	64(28.3)	2.48(1.55-3.97)	0.00
Physical Activity (MET minutes/week)				
High (at least 3000 MET minutes/week)	9(8.0)	41(18.1)	Ref	0.00
Low to Moderate	104(92.0)	188(81.9)	0.31(0.14-0.68)	

Table 2: Distribution of the study participants according to the non-modifiable factors

Variables	Cases	Controls	Odds ratio (95% CI)	P value
H/O Diabetes Mellitus in parents				
No	69(61.1)	189(83.6)	**Ref**	
Yes	44(38.9)	37(16.4)	**3.25(1.94-5.46)**	**0.00**
H/O Diabetes Mellitus in siblings				
No	80(70.8)	192(85.0)	**Ref**	
Yes	33(29.2)	34(15.0)	**2.32(1.35-4.01)**	**0.00**
Family H/O HTN				
No	62(54.9)	166(75.5)	**Ref**	
Yes	51(45.1)	60(26.5)	**2.27(1.41-3.65)**	**0.00**
Past H/O of GDM				
No	69(66.9)	161(96.4)	**Ref**	
Yes	34(33.1)	06(3.6)	**13.22(5.30-32.93)**	**0.00**
Past H/O of Abortion				
No	62(60.1)	12776.0)	**Ref**	
Yes	41(39.9)	40(24.0)	**2.09(1.23-3.57)**	**0.00**
Past H/O of congenital anomaly				
No	100(97.0)	163(97.6)	Ref	
Yes	03(3.0)	04(2.4)	1.22(0.26-5.57)	0.79
H/O pre term delivery				
No	93(90.2)	153(91.6)	Ref	
Yes	10(9.8)	14(10.4)	1.17(0.50-2.57)	0.71
H/O Intra uterine fetal death				
No	95(92.2)	163(97.6)	Ref	

Yes	08(7.8)	04(2.4)	1.17(0.51-2.75)	0.71
H/O macrosomia				
No	95(92.2)	162(97.0)	Ref	
Yes	08(08)	05(3.0)	2.72(0.86-8.58)	0.08
H/O polyhydramnios				
No	87(84.4)	156(93.4)	**Ref**	
Yes	16(15.6)	11(6.6)	**2.60(1.158-5.870)**	**0.02**
H/O polycystic ovarian syndrome				
No	96(85.0)	221(97.8)	**Ref**	
Yes	17(15.0)	05(2.2)	**8.0(2.87-22.31)**	**0.00**
H/O preeclampsia				
No	71(68.9)	145(86.8)	**Ref**	
Yes	32(31.1)	22(17.2)	**2.97(1.60-5.48)**	**0.00**

Table 3: Conditional logistic regression analysis for association of significant determinants with GDM

Variables	Category	Adjusted OR (95% CI)	p value
Weight gain till GDM diagnosis	<7kg	**Ref**	**0.00**
	>=7kg	**1.6 (1.2-2.0)**	
H/O Diabetes in parents	**No**	**Ref**	
	Yes	**5.24 (2.48-11.04)**	**0.00**
H/O Diabetes in siblings	No	Ref	
	Yes	2.00 (0.99-4.05)	0.05
H/O Hypertension in family	No	Ref	
	Yes	1.47 (0.77-2.81)	0.10
H/O GDM in previous pregnancy	**No**	**Ref**	
	Yes	**28.38 (9.71-82.88)**	**0.00**
H/O abortion	**No**	**Ref**	
	Yes	**6.58 (3.24-13.35)**	**0.00**
H/O congenital anomaly during past pregnancy	No	Ref	
	Yes	0.25 (0.00-9.12)	0.61
H/O macrosomia	No	Ref	
	Yes	0.74 (0.13-4.13)	0.87
H/O polyhydramnios	No	Ref	
	Yes	1.50 (0.45-4.95)	0.51
H/O polycystic ovarian syndrome	No	Ref	
	Yes	6.96 (2.04-23.74)	0.05
H/O pre-eclampsia	No	Ref	
	Yes	2.01 (0.85-4.75)	0.92
H/O intra uterine fetal death	No	Ref	
	Yes	5.86 (0.93-37.03)	0.06
H/O preterm delivery	No	Ref	
	Yes	1.80 (0.53-6.13)	0.34

4. Discussion

Gestational Diabetes Mellitus (GDM) is a significant public health concern, particularly in developing countries like India, where its prevalence is increasing due to rising obesity rates, sedentary lifestyles, and genetic predisposition. This study identified both modifiable and non-modifiable risk factors significantly associated with GDM among pregnant women in Kolkata. The findings align with existing literature while offering region-specific insights.

Among the non- modifiable factors A key finding in this study was the significant association between a family history of diabetes and the occurrence of GDM. This observation is consistent with a prospective cohort study conducted in Poland, which identified family history as an independent risk factor for GDM.[11] Similarly, a meta-analysis in Atlanta, Georgia, estimated an overall odds ratio of 3.46 (95% CI, 2.80–4.27) for family history as a predictor of GDM, further corroborating our results.[12] Moreover, a case-control study in Karnataka, India, observed significantly higher exposure rates for maternal and paternal history of diabetes among GDM cases compared to controls ($p < 0.001$), which aligns with the present study's findings emphasizing the hereditary influence on GDM development.[13] This supports the theory of genetic predisposition to insulin resistance.

History of GDM in the previous pregnancy is significantly associated with the GDM cases in this study. A study done in Turkey in 2015, disclosed that GDM in previous pregnancy is an important risk factor for the development GDM in future pregnancies, also statistically significant ($p<0.05$).[14] Another polish study in 2021 revealed that prior history of GDM is an important risk factor of causation of GDM and the association is found significant.[9] Again Rajput et al. a study in Haryana results showed history of GDM is significantly associated with GDM and has the highest odds ratio among all the other modifiable and non-modifiable risk factors these results support our current study findings.[15]

In this study almost two fifth of the cases had the prior history of abortion previous pregnancy, while only one fourth of controls presented with history of abortion. History of abortion is significantly related with causation gestational diabetes mellitus in the present study. Zhao Y et al. study result is like our study findings. Pregnant women who experienced only spontaneous abortion or both spontaneous abortion and induced abortion were at higher risk of developing GDM.[16] Muche A et al. a meta-analysis done in Africa shows that the odds of developing GDM in pregnant women with history of GDM is twice compared to those with no history of abortion.[17]

The role of polycystic ovarian syndrome (PCOS) in GDM development has been debated. The present study has found significant association (in regression model) between PCOS and GDM, similar with a 2016 study that identified PCOS as a risk factor.[18] Likewise, a 2018 study suggested that obesity and maternal age primarily drive the increased GDM risk in PCOS patients rather than PCOS itself.[19] More recent research has further concluded, that insulin resistance may be the primary underlying factor linking PCOS to GDM, necessitating further targeted investigations.

Additionally, Family history of hypertension,[15,20] a history of adverse pregnancy outcomes, like intrauterine fetal death,[21] congenital anomaly,[18] macrosomia,[17,18] was more prevalent among women diagnosed with GDM, supporting findings from research from similar studies suggest a potential link between previous obstetric complications and glucose intolerance during pregnancy. Although in this study no significant association was found.

Among the modifiable risk factors, parity, physical activity, obesity, and excessive weight gain during pregnancy were strong predictors of GDM.

In this study more than half cases have parity ≥2 and increase in parity is significantly associated with GDM. Mishra et al a case control study in Karnataka disclosed that Multiparity in women is significantly associated with GDM which corroborated in this study.[13] Lee et al study results showed that multiparous women had an increased risk of GDM in the subsequent pregnancy, compared to women who had neither of these conditions in their first pregnancy.[18] Contrary to this a study in Kerala revealed that increased parity is a known risk factor for GDM and not significantly associated with GDM.

In the present study Low to moderate level of physical activity has shown significant association with the development of GDM. Mishra et al a case control study in Karnataka has similar findings to this study that risk of developing GDM with moderate to low physical activity has significant association in pregnant women.[13] Deirdre et al a meta-analysis shows that higher levels of physical activity before pregnancy or in early pregnancy are associated with a significantly lower risk of developing GDM which corroborated with this study findings.[22]

Women who gained more than 7 kg during pregnancy had nearly 2.5 times the risk of developing GDM compared to those with lower weight gain. Rajput et al results revealed women diagnosed to have GDM had significant higher weight gain compared to non-GDM women.[15] Also, a case control study published in Karnataka presented that gestational weight gain ≥7kgs is significantly associated with GDM is a similar finding to our study. Previous studies, including a US-based prospective case control study, have demonstrated that obesity significantly increases the risk of both type 2 diabetes and GDM.[23] A study published in 2016 concluded that pre-pregnancy BMI alone is a crucial risk factor for GDM, irrespective of gestational weight gain. Additionally, recent research has highlighted that excessive gestational weight gain itself may exacerbate insulin resistance, further elevating the risk of GDM.[24] Our findings align with these results, emphasizing the necessity for targeted interventions focusing on both pre-pregnancy BMI and gestational weight management in women of reproductive age.

However, this study has some limitations, such as recall bias in self-reported data (e.g., physical activity), hospital-based sampling may limit generalizability, lack of dietary intake assessment, which could confound associations with BMI and physical activity.

5. Conclusion

In conclusion, this study provides insights into the risk factors associated with GDM, highlighting the interaction between genetic, lifestyle, and socioeconomic factors. Addressing modifiable risk factors through early intervention programs, promoting healthy dietary practices, and encouraging physical activity can significantly reduce the burden of GDM and its associated complications. Future research should focus on larger population-based studies to validate these findings and formulate effective prevention strategies.

6. Source of Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

7. Conflict of Interest

The authors declare no conflict of interest.

8. Ethical Approval

The study was approved by the Institutional Ethics Committee of the College of Medicine and Sagore Dutta Hospital, Kolkata.

9. Acknowledgments

The authors would like to thank the participants, the staff of the Department of Obstetrics and Gynaecology, and the Department of Community Medicine at the College of Medicine and Sagore Dutta Hospital for their support and cooperation.

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Cite this article: Ghosh S, Mukhopadhyay DK, Das N, Karmakar KS. Factors associated with gestational diabetes mellitus: a case control study in a tertiary care hospital in Kolkata, west Bengal. *Indian J Obstet Gynecol Res.* 2025;12(4):739–745.