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Original Article

Antenatal Insulin Requirement in Women with Gestational Diabetes Mellitus

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ABSTRACT

Background: Gestational diabetes mellitus (GDM) is a common metabolic disorder of pregnancy associated with adverse maternal and neonatal outcomes. While medical nutritional therapy (MNT) is the first-line treatment, a substantial proportion of women require insulin therapy. Identifying predictors of insulin requirement is essential for timely intervention and improved outcomes.
Methods: This cross-sectional study was conducted over 18 months at a tertiary care hospital in Secunderabad, Telangana. A total of 200 antenatal women with singleton pregnancies diagnosed with GDM using DIPSI criteria were included. Participants were initially managed with MNT and monitored for glycemic control. Insulin therapy was initiated in women who failed to achieve target glucose levels. Demographic, clinical, and biochemical parameters were analyzed, and maternal and neonatal outcomes were compared between insulin-requiring and non–insulin-requiring groups.
Results: Insulin was required in 20% of women. Higher maternal age, increased BMI, later gestational age at diagnosis, elevated postprandial glucose levels, family history of diabetes, and gestational hypertension were significantly associated with insulin requirement. Insulin-treated women had higher rates of cesarean delivery, large-for-gestational-age babies, neonatal hypoglycemia, and hyperbilirubinemia.
Conclusion: Several maternal and metabolic factors predict insulin requirement in GDM, highlighting the importance of early identification and individualized management to improve pregnancy outcomes.

Keywords: *Gestational diabetes mellitus; Insulin requirement; Body mass index; Postprandial blood glucose.*

INTRODUCTION

Gestational diabetes mellitus (GDM) is one of the most prevalent metabolic disorders encountered during pregnancy, characterized by carbohydrate intolerance of variable severity, which is either first recognized or begins during pregnancy (1). Globally, the prevalence of GDM is around 15% of pregnancies. In India, the prevalence of GDM is ranging from 12% to 21%. Prevalence in Telangana state is 11.5%. GDM poses significant risks for adverse maternal and fetal outcomes, including preeclampsia, macrosomia, cesarean delivery, neonatal hypoglycemia, and long-term metabolic disorders in offspring (2,3). Effective management of GDM can mitigate these risks and is vital for improving maternal and neonatal health outcomes. Timely and accurate identification of women requiring insulin therapy is crucial for optimizing glycemic control and preventing complications. While medical nutritional therapy (MNT) remains the first-line approach, approximately 30% to 50% of women with GDM require pharmacological intervention, with insulin being the preferred choice due to its safety profile. However, insulin therapy poses challenges, including patient adherence, risk of hypoglycemia, and the need for frequent monitoring. By identifying predictive factors for insulin therapy, the study seeks to contribute to the development of targeted interventions that align with the principles of precision medicine.

AIMS

1. To study factors associated with insulin requirement in women with gestational diabetes Mellitus
2. To determine the maternal and fetal outcomes in patients managed on insulin

METHODS

This was a cross-sectional study carried out over 18 months in the Department of Obstetrics and Gynecology at a tertiary care Hospital in Secunderabad- Telangana.

The study population comprised all antenatal women with singleton pregnancies attending hospital and diagnosed as Gestational Diabetes according to DIPSI criteria.

The DIPSI test requires pregnant women to ingest 75 grams of glucose dissolved in 250– 300 mL of water. A single venous blood sample is taken 2 hours later to measure plasma glucose levels. A cutoff value of ≥140 mg/dL is considered diagnostic of GDM.

Those excluded from the study were women with overt diabetes mellitus identified before the pregnancy, pre-existing hypertension, multiple pregnancies, presence of systemic diseases such as liver or renal failure and autoimmune disorders. Convenience sampling was employed, enrolling all eligible participants who consented to take part in the study and the sample size required was 200.

Eligible participants underwent a detailed assessment at the time of recruitment. This included recording demographic details (age, gestational age, parity, family history), anthropometric measurements (BMI), and baseline glycemic status. Participants were managed initially with medical nutritional therapy (MNT), including dietary modifications and moderate exercise, for two weeks. Fasting and postprandial blood glucose levels were monitored during this period. Participants who failed to achieve glycemic targets (fasting blood sugar >95 mg/dL and postprandial blood sugar >120 mg/dl were prescribed insulin therapy. NPH (basal insulin) is given twice daily with two thirds} of total daily dose given before breakfast and one third before dinner. Actrapid (rapid acting insulin) is typically administered before each meal. Total daily insulin is divided into basal insulin (NPH) and bolus insulin components(actrapid).Titration of NPH was done increasing the dose based on fasting blood glucose levels, and Actrapid dose based on post- prandial blood glucose levels to achieve tight glycemic control. Patients were counselled to do intensive self monitoring with all 3 pre meals and 2hr post meal glucose. The dose was increased by 2-4 units/day if blood glucose levels are more than target ranges. Fasting glucose levels are measured after an overnight fast of 8–10 hours and levels above 92 mg/dL are considered abnormal. Postprandial glucose levels are measured 1–2 hours after consuming a standardized meal or glucose, to maintain target glucose levels at <120 mg/dL at 2 hours.

Independent variables included gestational age at diagnosis, BMI, fasting and postprandial blood glucose levels, and family history of diabetes. Outcome variables included the requirement for insulin therapy, mode of delivery, and maternal and neonatal outcomes.

Statistical Analysis: The statistical analysis employed in this study focused on comparing demographic, clinical, and laboratory parameters between participants requiring insulin and those who did not. Descriptive statistics were used to summarize continuous variables such as age, gestational age at diagnosis and delivery, blood glucose levels, weight, height, and BMI as means and standard deviations (SD).

Categorical variables, including gestational hypertension, mode of delivery, family history of diabetes, and neonatal outcomes, were summarized as frequencies and percentages. Continuous variables were compared using an independent two-sample t-test to identify statistically significant differences between the two groups. To examine associations between categorical variables and insulin requirement, the Chi-square test was applied. A p-value <0.05 was considered as significant.

RESULTS

The frequency distribution of insulin requirement among the study participants shows that 20.0% (n=40) required insulin, while the majority, 80.0% (n=160), did not. This indicates that the prevalence of insulin dependency in the study population was relatively low.

The mean age of participants requiring insulin was 30.60 years (SD: 1.78), compared to 27.36 years (SD: 1.86) for those not requiring insulin. The difference was statistically significant ($t = -3.79$, $p = 0.0002$), suggesting that older age may be associated with increased insulin.

Participants requiring insulin had a significantly higher mean gestational age at diagnosis (33.86 weeks; SD: 2.06) than those not requiring insulin (27.36 weeks; SD: 1.87). The difference was statistically significant ($t = -7.41$, $p < 0.001$), indicating that later gestational age at diagnosis may be linked to insulin requirement. The mean gestational age at delivery was lower in the insulin-requiring group (36.78 weeks; SD: 1.10) compared to those not requiring insulin (38.17 weeks; SD: 0.95). This difference was highly significant ($t = -8.02$, $p < 0.001$), suggesting an association between insulin requirement and earlier delivery.

The mean fasting blood sugar level was slightly higher in the insulin-requiring group (90.60 mg/dL; SD: 5.04) compared to those not requiring insulin (89.89 mg/dL; SD: 4.91), but the difference was not statistically significant (t = -0.82, p = 0.415), indicating no strong association. The mean postprandial blood sugar level was significantly higher in the insulin-requiring group (133.73 mg/dL; SD: 11.64) compared to those not requiring insulin (121.04 mg/dL; SD: 5.35). The difference was statistically significant (t = -2.16, p = 0.032), suggesting that elevated postprandial glucose levels are linked to insulin requirement.

Participants requiring insulin had a significantly higher mean weight (61.15 kg; SD: 3.14) than those not requiring insulin (57.65 kg; SD: 2.92). The difference was highly significant (t= -6.68, p < 0.001), indicating that increased weight may be associated with insulin requirement. The mean height of participants requiring insulin (1.560 m; SD: 0.021) was similar to those not requiring insulin (1.558 m; SD: 0.020), and the difference was not statistically significant (t = -0.65, p = 0.516), suggesting no association between height and insulin requirement.

Table 1: Association of family history of diabetes with insulin requirement

Family history of diabetes	Insulin required n (%)	Insulin not required n (%)	P value
Yes	38 (95.0%)	10 (6.25%)	
No	2 (5.0%)	150 (93.75%)	<0.001

This table highlights the relationship between family history of diabetes and insulin requirement. A significant 95.0% of participants with a family history of diabetes required insulin, while only 6.25% of those without a family history needed insulin. Conversely, 93.75% of participants without a family history did not require insulin, compared to only 5.0% of those with a family history. The association is highly significant with a p-value of<0.001, suggesting a strong link between family history of diabetes and insulin requirement.

Table 2: Comparison of BMI Between Groups

Insulin Requirement	Mean BMI	SD	t	p-value
Yes	25.08	0.92		
No	23.77	1.04	-7.26	<0.001

Participants requiring insulin had a significantly higher mean BMI (25.08 kg/m²; SD: 0.92) compared to those not requiring insulin (23.77 kg/m²; SD: 1.04). The difference was highly significant (t = -7.26, p < 0.001), indicating that higher BMI is strongly associated with insulin requirement.

Table 3: Association of gestational hypertension with insulin requirement

Gestational hypertension	Insulin required n (%)	Insulin not required n (%)	P value
Yes	20 (50.0%)	20 (50.0%)	<0.001
No	20 (12.5%)	140 (87.5%)	

This table illustrates the association between gestational hypertension and insulin requirement. Among participants with gestational hypertension, 50.0% required insulin, compared to 12.5% of those without gestational hypertension. Conversely, 50.0% of participants with gestational hypertension did not require insulin, whereas 87.5% of those without hypertension did not need insulin. The significant association is evident with a p- value of <0.001, suggesting that gestational hypertension is more prevalent among those requiring insulin.

.Table 4: Association of mode of delivery with insulin requirement

Mode of delivery	Insulin required n (%)	Insulin not required n (%)	P value
Cesarean	24 (60.0%)	60 (37.5%)	0.010
Vaginal	16 (40.0%)	100 (62.5%)	

This table examines the mode of delivery and its association with insulin requirement. Cesarean delivery was observed in 60.0% of participants requiring insulin, compared to 37.5% of those not requiring insulin. In contrast, vaginal delivery occurred in 40.0% of participants needing insulin and 62.5% of those who did not require insulin. The association is statistically significant with a p-value of 0.010, indicating that insulin requirement is linked to an increased likelihood of cesarean delivery

Table 5 : MATERIAL COMPLICATIONS

Parameter	overall	MNT	Insulin	Pvalue
	200	160	40	
PPH	2(1%)	1(0.6%)	1(2.5%)	0.586
Surgical site infection	5(2.5%)	2(1.2%)	3(7.5%)	0.054

p- value > 0.05 Statistically not significant

Out of 200 participants,160 (80%) were well controlled on MNT. Insulin was required in 40 participants. The rates of cesarean delivery (42%) were significantly higher in insulin treated group than in MNT group. However there was no difference in rates of postpartum hemorrhage, surgical site infections, and indications of cesarean delivery in two groups.

Table 6: Association of LGA babies with insulin requirement

LGA babies	Insulin required n (%)	Insulin not required n (%)	P value
Yes	21 (52.5%)	7 (4.38%)	
No	19 (47.5%)	153 (95.62%)	<0.001

This table explores the association between LGA (large-for-gestational-age) babies and insulin requirement. Among participants requiring insulin, 52.5% had LGA babies, compared to 4.38% of those not requiring insulin. Conversely, 95.62% of participants without LGA babies did not require insulin, while 47.5% of participants requiring insulin had non-LGA babies. The association is significant with a p-value of <0.001, suggesting a strong link between LGA babies and insulin requirement.

Table 7: Association of neonatal hyperbilirubinemia with insulin requirement

Neonatal hyperbilirubinemia	Insulin required n (%)	Insulin not required n (%)	P value
Yes	27 (67.5%)	0 (0.0%)	
No	13 (32.5%)	160 (100.0%)	<0.001

This table highlights the relationship between neonatal hyperbilirubinemia and insulin requirement. Neonatal hyperbilirubinemia was observed in 67.5% of participants requiring insulin, while none of the participants not requiring insulin experienced hyperbilirubinemia. Conversely, 100.0% of participants without hyperbilirubinemia did not require insulin, while 32.5% of those requiring insulin had no hyperbilirubinemia. The significant p-value of <0.001 indicates a strong association between neonatal hyperbilirubinemia and insulin requirement.

Table 8: Association of congenital heart disease with insulin requirement

Congenital heart disease	Insulin required n (%)	Insulin not required n (%)	P value
Yes	1 (2.5%)	1 (0.62%)	
No	39 (97.5%)	159 (99.38%)	0.286

This table examines the relationship between congenital heart disease and insulin requirement. Among participants requiring insulin, 2.5% had congenital heart disease compared to 0.62% of those not requiring insulin. Conversely, 99.38% of participants without congenital heart disease did not require insulin, while 97.5% of those requiring insulin were free from congenital heart disease. The p-value of 0.286 indicates no significant association between congenital heart disease and insulin requirement.

Table 9: Association of Neonatal Death with Insulin Requirement

Neonatal Death	**Insulin Required n (%)**	**Insulin Not Required n (%)**	**P value**
Yes	1 (2.5%)	1 (0.6%)	0.286
No	39 (97.5%)	159 (99.4%)	

This table explores the association between neonatal death and insulin requirement. Neonatal death occurred in 2.5% of participants requiring insulin and 0.6% of those not requiring insulin. Among those without neonatal death, 97.5% required insulin, and 99.4% did not require insulin. The p-value of 0.286 suggests no statistically significant association between neonatal death and insulin requirement.

Table 10: Association of hypoglycemia in babies with insulin requirement

Hypoglycemia	Insulin required n (%)	Insulin not required n (%)	P value
Yes	11 (27.5%)	4 (2.5%)	<0.001
No	29 (72.5%)	156 (97.5%)	

This table explores the relationship between hypoglycemia and insulin requirement. Among those requiring insulin, 27.5% of babies experienced hypoglycemia compared to only 2.5% of those not requiring insulin. Conversely, 97.5% of babies without hypoglycemia did not require insulin, while 72.5% of those with hypoglycemia required insulin. The association is statistically significant with a p-value of <0.001, indicating a strong relationship between hypoglycemia and insulin requirement.

DISCUSSION

Gestational diabetes mellitus (GDM) represents a critical area in maternal-fetal medicine, as it poses significant risks for both maternal and neonatal health. The findings of this study provide valuable insights into factors influencing insulin requirement among women with GDM and their associated outcomes. Our results revealed that older maternal age was significantly associated with insulin requirement, a finding consistent with Langer et al., who observed that advancing maternal age contributes to higher insulin resistance during pregnancy, leading to increased insulin needs (1). The gestational age at which GDM was diagnosed emerged as another important factor in our study. Women requiring insulin were diagnosed later in pregnancy compared to those managed without insulin. This aligns with findings from Catalano et al.(4), who demonstrated that delayed diagnosis of GDM leads to a prolonged period of unregulated hyperglycemia, thereby increasing the likelihood of insulin therapy Early identification and intervention could mitigate this risk, underscoring the need for universal glucose tolerance screening in mid-pregnancy, as recommended by ACOG guidelines (5).

A significant association between higher body mass index (BMI) and insulin requirement was also observed, echoing findings by Simmons et al.(6), who identified obesity as a primary contributor to insulin resistance in GDM Obese women with GDM experience heightened metabolic demands during pregnancy, exacerbating their pre-existing insulin resistance. The role of pre-pregnancy BMI management through lifestyle interventions, including dietary and physical activity modifications, is crucial in mitigating GDM-related risks.

Our findings regarding fasting and postprandial blood glucose levels further emphasize the importance of glycemic control in managing GDM. Higher fasting and postprandial glucose levels in insulin-requiring women are consistent with prior studies, including Weiss et al. (7), who demonstrated that these parameters are critical in predicting fetal macrosomia and other complications. The relationship between elevated postprandial glucose levels and poor pregnancy outcomes, as highlighted by Langer et al. (8), underscores the importance of achieving postprandial glycemic targets through individualized insulin regimens.

Neonatal complications, including large-for-gestational-age (LGA) babies and hyperbilirubinemia, were significantly associated with insulin dependency. This is consistent with findings from the HAPO study(2), which demonstrated that poorly controlled maternal hyperglycemia increases the risk of fetal overgrowth and subsequent neonatal morbidities. Gestational hypertension, a significant comorbidity in our study, was more prevalent among insulin-requiring women. This finding corroborates Coustan et al.(2), who highlighted the bidirectional relationship between GDM and hypertensive disorders in pregnancy.

Family history of diabetes emerged as a significant predictor of insulin requirement, emphasizing the genetic predisposition to glucose intolerance. This aligns with findings by Watanabe et al.(9), who demonstrated that women with a family history of diabetes are at a higher risk of developing severe hyperglycemia during pregnancy. Genetic counseling and early metabolic screenings are essential in this high-risk group to mitigate adverse outcomes.

While congenital anomalies, such as congenital heart disease, were not significantly different between groups, this aligns with Catalano et al.(5), who noted that such anomalies are more strongly associated with pregestational diabetes than GDM .

Our study also highlighted the role of maternal weight in insulin dependency. Women requiring insulin had significantly higher weights compared to their counterparts. This finding supports prior research by Bakiner et al.(10), who reported that maternal adiposity amplifies insulin resistance, necessitating pharmacologic intervention. Addressing weight gain during pregnancy through personalized nutritional and physical activity plans may help reduce insulin dependency.
Although neonatal mortality was not significantly associated with insulin requirement in our study, the finding reflects improvements in obstetric and neonatal care practices.

CONCLUSION

This study highlights key clinical, demographic, and biochemical factors associated with insulin requirement among pregnant women with gestational diabetes mellitus (GDM). The findings emphasize that older maternal age, higher BMI, later gestational age at diagnosis, and elevated glucose levels on OGTT and postprandial blood sugar tests are significant predictors of insulin dependency. Additionally, maternal complications such as gestational hypertension and neonatal outcomes, including hyperbilirubinemia and LGA babies, were more prevalent in the insulin-requiring group, underscoring the importance of tailored management strategies in this high- risk population. A strong association with family history of diabetes further suggests the need for targeted screening and early interventions in at-risk individuals.

The study provides valuable insights into the management of GDM, offering guidance for clinicians to identify women who may benefit from closer monitoring and early insulin therapy. While some outcomes, such as congenital heart disease and neonatal death, showed no significant association, the overall findings underscore the multifactorial nature of insulin dependency in GDM. Future research should focus on larger, prospective cohorts to validate these findings and explore

interventions that could mitigate the identified risks, ensuring better maternal and neonatal outcomes.

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