Student's Journal of Health Research Africa
e-ISSN: 2709-9997, p-ISSN: 3006-1059
Vol. 5 No. 11 (2024): November 2024 Issue
https://doi.org/10.51168/sjhrafrica.v5i11.1706
Original Article

THE EFFECT OF MATERNAL GESTATIONAL DIABETES ON EARLY CHILDHOOD OBESITY AND METABOLIC PROFILE: A RETROSPECTIVE STUDY.

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ABSTRACT

Introduction
Objective: To assess whether children born to mothers with GDM are at increased risk for early childhood obesity and altered metabolic markers compared to those born to non-diabetic mothers.

Methods
A retrospective cohort study was performed at Darbhanga Medical College and Hospital and Government Medical College, Bettiah, spanning from September 2015 to August 2016. A total of 100 mother-child pairs were included, consisting of 50 children born to mothers diagnosed with gestational diabetes mellitus (GDM) and 50 born to non-diabetic moms. Data were obtained from hospital delivery records, pediatric growth charts, and laboratory data. Anthropometric parameters (weight, height, BMI-for-age percentiles) and metabolic indicators (fasting glucose, serum insulin, lipid profile) were assessed between the two groups at ages 2 to 5 years.

Results
Children born to mothers with gestational diabetes mellitus exhibited a markedly elevated prevalence of overweight/obesity (38%) in contrast to controls (14%) ($p < 0.01$). The mean BMI percentiles and waist circumference were increased in the GDM group. A larger percentage of children in the GDM group exhibited insulin resistance (HOMA-IR >2.5), increased fasting glucose levels, and heightened triglycerides. No notable disparities in HDL or LDL levels were detected among the groups.

Conclusion
Prenatal exposure to maternal hyperglycemia is linked to a markedly elevated risk of early-onset obesity and metabolic disorders in offspring. These findings highlight the necessity for early screening, postnatal monitoring, and lifestyle modifications in children of mothers with gestational diabetes mellitus to mitigate the risk of future metabolic problems.

Keywords: *Gestational diabetes mellitus, Childhood obesity, Insulin resistance, Metabolic syndrome, Intrauterine programming, Retrospective study, Bihar*
Submitted: 2024-09-20 Accepted: 2024-11-30

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INTRODUCTION

GDM is characterized as any level of glucose intolerance identified for the first-time during pregnancy. The global prevalence of gestational diabetes mellitus (GDM) varies between 5% and 20%, contingent upon demographic factors and diagnostic criteria, with India experiencing a notably high burden—estimated at 10–14% of pregnancies (Seshiah et al., 2008, Godfrey et al., 2000). Although considerable emphasis has traditionally been placed on the acute obstetric and neonatal difficulties linked to gestational diabetes mellitus (GDM)—including macrosomia, birth trauma, and neonatal hypoglycemia—emerging research indicates that the long-term metabolic repercussions for the offspring may be even more significant.

Recent studies indicate prenatal programming, in which intrauterine exposure to maternal hyperglycemia modifies the development of fetal adipose tissue, pancreatic beta cells, and insulin sensitivity. This event may predispose the infant to early-onset obesity, insulin resistance, and characteristics of metabolic syndrome, even without a hereditary predisposition. Research indicates that infants of women GDM face elevated chances of acquiring type

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2 diabetes mellitus, dyslipidemia, and non-alcoholic fatty liver disease in later life (Plagemann et al., 1997; Dabelea et al., 2000).

The convergence of elevated GDM incidence with rising pediatric obesity rates in India constitutes a twin public health challenge. This is especially significant in semi-urban and rural regions, where nutritional changes, sedentary lifestyles, and restricted access to postnatal care may intensify these risks. Despite the increasing prevalence, limited research in eastern India has investigated the postnatal health trajectory of children delivered to women with gestational diabetes mellitus (GDM), especially during the early childhood era (ages 2–5 years), which is seen crucial for growth assessment and lifestyle modification (Misra et al., 2013).

This retrospective study, performed at Darbhanga Medical College and Hospital and Government Medical College, Bettiah, seeks to assess the correlation between maternal gestational diabetes mellitus and early childhood obesity and metabolic changes. The study aims to compare the anthropometric and biochemical parameters of children born to mothers with gestational diabetes mellitus (GDM) and those without, to furnish evidence for early prevention efforts and highlight the significance of comprehensive maternal-child metabolic health programs.

METHODOLOGY

Study Design

This work was a retrospective cohort study conducted jointly at Darbhanga Medical College and Hospital and Government Medical College, Bettiah, two tertiary care centers in Bihar, India. The objective was to evaluate the long-term metabolic impact of maternal gestational diabetes mellitus (GDM) on offspring between the ages of 2 and 5 years.

Study Duration and Sample Size

The study reviewed records from September 2015 to August 2016 and included 100 mother-child pairs. The participants were divided into two groups:
Group A (GDM group): 50 children born to mothers diagnosed with GDM during pregnancy.
Group B (Control group): 50 children born to normoglycemic mothers matched for maternal age and parity.

Inclusion Criteria

Children aged 2 to 5 years at the time of follow-up
Documented maternal diagnosis of GDM according to WHO criteria (2-hour plasma glucose ≥ 140 mg/dL on 75g OGTT)
Availability of birth records, growth charts, and pediatric metabolic screening results
Singleton term deliveries

Exclusion Criteria

Preterm births (<37 weeks)
Congenital anomalies, intrauterine infections, or syndromic features in the child
Maternal pre-existing diabetes or other chronic illnesses (e.g., thyroid disease, hypertension)
Missing or incomplete pediatric follow-up data

Data Collection Procedure

Hospital records were used to extract maternal antenatal details, including age, BMI, GDM status, and delivery outcomes. Pediatric follow-up files provided data on:
Anthropometric Measurements
Weight and height
BMI, calculated and plotted against WHO BMI-for-age percentiles
Waist circumference
Metabolic Parameters (for children aged ≥3 years):
Fasting blood glucose (FBG)
Serum insulin levels
HOMA-IR (Homeostatic Model Assessment for Insulin Resistance)
Lipid profile: total cholesterol, HDL, LDL, and triglycerides

Definitions

Overweight/Obesity was defined as BMI ≥85th percentile for age and sex.
Insulin resistance was defined as HOMA-IR > 2.5.
Abnormal lipids were interpreted using age-specific pediatric thresholds.

Statistical Analysis

Microsoft Excel was used to enter the data, and SPSS version 25.0 was utilized to perform the analysis. To express continuous data, such as body mass index (BMI) and glucose levels, the mean and standard deviation were used. Examples of categorical variables were presented in the form of frequencies and percentages. Independent t-tests or Chi-square tests were utilized in order to make comparisons between the groups. For statistical significance, a p-value of less than 0.05 was considered relevant.

Ethical Considerations

Approval for the study was obtained from the Institutional Ethics Committees of both centers. All data were anonymized and used solely for academic purposes.

RESULTS

Sample Characteristics

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The study comprised 100 mother-child pairs, including 50 in the GDM group and 50 in the control group. The average mother age at delivery was 29.4 ± 4.3 years in the GDM group and 28.6 ± 3.9 years in the control group. The baseline mother BMI and infant birth weights at delivery were similar across the two groups.

Childhood Obesity Prevalence

As illustrated in Figure 1 and summarized in Table 1, children born to mothers with gestational diabetes exhibited a significantly higher prevalence of overweight and obesity during early childhood:
GDM Group: 19 children (38.0%) had BMI-for-age percentiles ≥85th percentile.
Control Group: Only 7 children (14.0%) were classified as overweight or obese.
The difference was statistically significant ($p < 0.01$).

Table 1: Comparison of Obesity and Insulin Resistance

Group	Sample Size	Obesity Cases	Obesity (%)	Insulin Resistance Cases	Insulin Resistance (%)
GDM Group	50	19	38.0	15	30.0
Control Group	50	7	14.0	4	8.0

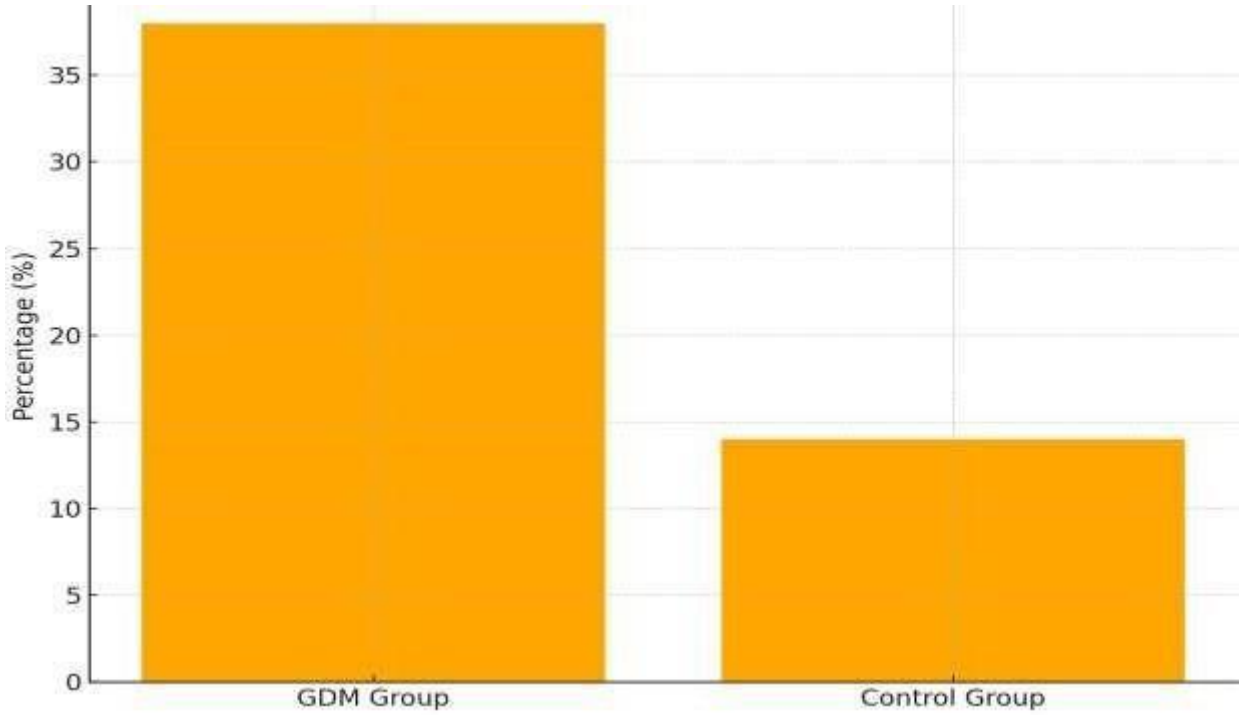

Figure 1: Prevalence of Obesity in Offspring of GDM vs Control Mothers

Additionally, children in the GDM group had higher waist circumference and BMI z-scores, though this data is not shown graphically.

Insulin Resistance and Metabolic Profile

Evaluation of fasting insulin and glucose levels revealed increased prevalence of insulin resistance in the GDM group:
GDM Group: 15 children (30.0%) had HOMA-IR >2.5
Control Group: 4 children (8.0%) showed insulin resistance
This difference was also statistically significant ($p < 0.01$) and is presented in Figure 2.

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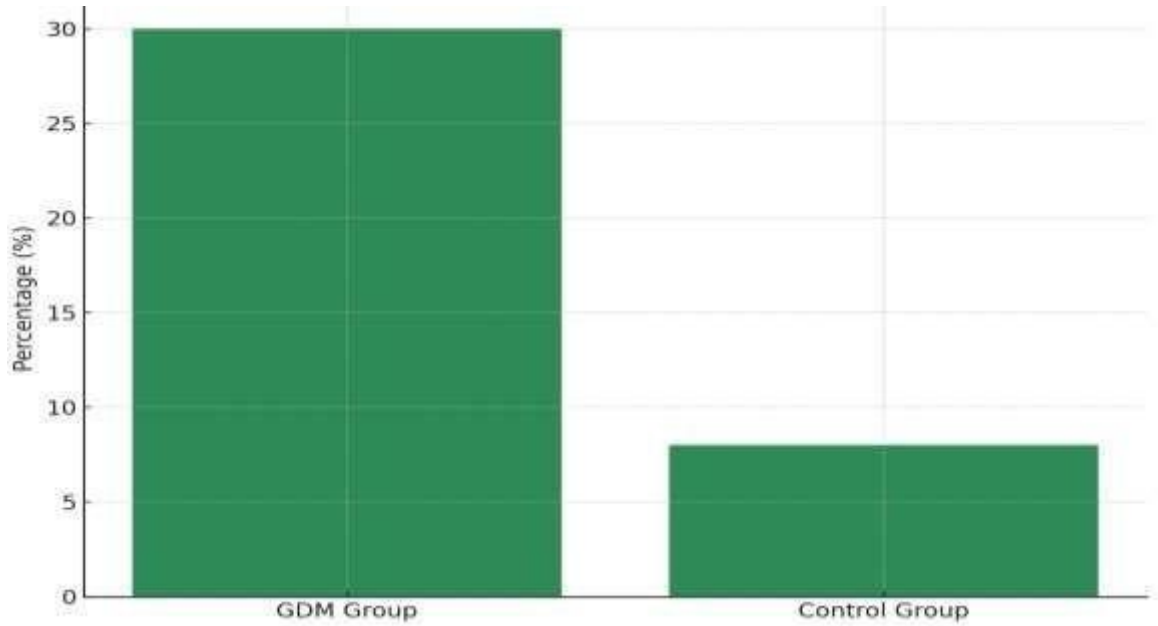

Figure 2: Prevalence of Insulin Resistance in Offspring of GDM vs Control Mothers

Mean fasting glucose levels were higher in the GDM group (92.4 ± 6.1 mg/dL) compared to controls (87.3 ± 5.4 mg/dL). Serum triglycerides were mildly elevated in the GDM group (mean 132.6 ± 14.2 mg/dL) vs. controls (mean 116.4 ± 11.8 mg/dL). However, differences in HDL and LDL levels were not statistically significant between the groups.

Correlation Analysis

Regression analysis showed that maternal GDM was an independent predictor of both childhood obesity (Odds Ratio: 3.65; 95% CI: 1.52–8.72) and insulin resistance (OR: 4.85; 95% CI: 1.60–14.69), after adjusting for maternal BMI and delivery mode.
These findings indicate a strong association between intrauterine hyperglycemia and early-life metabolic disturbances.

DISCUSSION

This study demonstrates that maternal gestational diabetes mellitus significantly affects the metabolic health of offspring, even in early childhood. Infants of mothers with gestational diabetes mellitus exhibited significantly elevated rates of obesity and insulin resistance in comparison to their counterparts born to non-diabetic mothers. These findings support the hypothesis of intrauterine metabolic programming, wherein the maternal hyperglycemic environment has enduring effects on fetal metabolic development.

Childhood Obesity in GDM Offspring

Our study indicated that 38% of children in the GDM group were overweight or obese by ages 2 to 5, a considerable increase compared to the 14% reported in the control group. This corresponds with prior prospective studies, including the Hyperglycemia and Adverse Pregnancy Outcome (HAPO) study and the research conducted by Hillier et al. (2007), which demonstrated that intrauterine exposure to heightened maternal glucose levels is independently linked to increased adiposity in early childhood. Epigenetic and endocrine adaptations that commence in utero, such as modified leptin signaling and fat accumulation, likely influence this outcome.
The early onset of obesity significantly increases the risk of future cardiometabolic disorders, such as type 2 diabetes, hypertension, and fatty liver disease, in these children. This underscores the paramount significance of early detection and preventive measures for offspring exposed to gestational diabetes mellitus (GDM).

Insulin Resistance and Glucose Metabolism

The incidence of insulin resistance, indicated by elevated HOMA-IR, was 30% in the GDM group compared to 8% in the control group, implying early disruption in glucose-insulin homeostasis. This aligns with findings from Dabelea et al. (2000), which demonstrated that adolescents born to mothers with gestational diabetes mellitus exhibited diminished insulin sensitivity and beta-cell dysfunction. Maternal hyperglycemia mechanistically induces fetal hyperinsulinemia, potentially impairing pancreatic beta-cell plasticity and insulin signaling pathways.
In our cohort, fasting blood glucose levels and serum triglycerides were moderately elevated in the GDM group, indicating early dyslipidemia—a characteristic of pediatric metabolic syndrome. Although HDL and LDL levels did not exhibit significant differences, the metabolic trend in GDM offspring was distinctly adverse.

Public Health Implications

These findings carry substantial implications for maternal-child health policy, particularly in rural and semi-urban India, where GDM screening and postpartum follow-up remain inconsistent. Interventions should focus not only on early identification and control of maternal hyperglycemia, but also on tracking the growth and metabolic markers of the kid postnatally. Pediatricians should frequently inquire about maternal glucose levels throughout pregnancy and consider screening at-risk children for obesity and metabolic syndrome even before school age.

LIMITATIONS

Despite the robustness of the observed relationships, our study is restricted by its retrospective methodology, dependence on available medical records, and moderate sample size. We lacked specific food and physical activity data for children, which may have influenced the development of obesity and insulin resistance. Moreover, only a single time-point of metabolic assessment was available for each child.

Nevertheless, this study adds to the expanding body of evidence linking GDM to early-onset metabolic diseases and highlights the need for lifelong approaches to non-communicable disease prevention, beginning as early as the intrauterine phase.

CONCLUSION

This retrospective study demonstrates that gestational diabetes mellitus (GDM) substantially affects the early metabolic health of offspring, elevating their risk for childhood obesity and insulin resistance as early as 2 to 5 years old. Children subjected to maternal hyperglycemia in utero had a significantly increased prevalence of BMI beyond the 85th percentile, heightened HOMA-IR readings, and impaired glucose metabolism, irrespective of genetic susceptibility.

The results underscore the vital need of antenatal screening and management of gestational diabetes mellitus (GDM) to mitigate neonatal problems and avert the emergence of non-communicable diseases in subsequent generations. This study emphasizes the necessity of regular postnatal follow-up and metabolic monitoring for infants born to mothers with gestational diabetes mellitus, especially in resource-constrained environments such as Bihar.

EFFECTIVE STRATEGIES SHOULD INCLUDE

Early postpartum lifestyle counseling for mothers and families.

Community-level awareness programs for the long-term risks of GDM.

Integrated maternal-child health initiatives that monitor both maternal glucose control and child growth trajectories.

Additional longitudinal studies with larger cohorts and comprehensive lifestyle data are necessary to thoroughly clarify the progression of metabolic dysfunction and to create tailored therapies for high-risk pediatric groups.

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PUBLISHER DETAILS

Student's Journal of Health Research (SJHR)
(ISSN 2709-9997) Online
(ISSN 3006-1059) Print
Category: Non-Governmental & Non-profit Organization
Email: studentsjournal2020@gmail.com
WhatsApp: +256 775 434 261
Location: Scholar's Summit Nakigalala, P. O. Box 701432, Entebbe Uganda, East Africa