



CONSEQUENCES OF FETAL GROWTH RESTRICTION DUE TO MATERNAL HIGH-RISK FACTORS ON NEONATAL OUTCOME WITH 1-YEAR FOLLOW-UP IN A TERTIARY CARE HOSPITAL: A COHORT STUDY.

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ABSTRACT

Background

Fetal growth restriction (FGR) is a significant perinatal concern associated with increased neonatal morbidity and long-term pediatric complications. Maternal high-risk factors such as hypertension, diabetes, malnutrition, and infections are known contributors to FGR.

Objectives

- To clarify the relationship between maternal high-risk variables and the pediatric effects of FGR.
- To evaluate the pediatric outcome after 1-year follow-up.

Methods

A prospective observational study was conducted at IGIMS, Patna, over 1.5 years involving 92 FGR neonates. Maternal risk factors and neonatal outcomes were recorded, with follow-up assessments up to 12 months to evaluate growth and development.

Results

A total of 92 neonates with fetal growth restriction (FGR) born to high-risk mothers were enrolled. The mean maternal age was 28.4 ± 4.7 years; 48.9% were primiparous. Hypertensive disorders (52.2%) and diabetes mellitus (19.6%) were the most common maternal risk factors. Neonatal outcomes included hypoglycemia (37.0%), respiratory distress (31.5%), and NICU admission (55.4%). Significant correlations were found between maternal hypertension and NICU admission ($p=0.003$), and between diabetes and neonatal hypoglycemia ($p=0.001$). At 12-month follow-up, 29.3% had delayed developmental milestones, and 33.7% showed persistent growth impairment, indicating a strong association between maternal risks and adverse pediatric outcomes.

Conclusion

Maternal high-risk conditions significantly affect both immediate and long-term outcomes in FGR neonates. Early antenatal intervention and structured pediatric follow-up are essential to improve prognosis.

Keywords: Fetal growth restriction, maternal risk factors, neonatal outcomes, developmental delay.

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INTRODUCTION

A fetus's incapacity to reach its genetically determined growth potential is known as fetal growth restriction (FGR), a medical disease that causes substantial morbidity and mortality during infancy and childhood [1]. When fetal biometric data, including estimated fetal weight or abdominal circumference, drop below the 3rd centile for gestational age or below the 10th centiles with

abnormal Doppler finding (umbilical artery PI > 95 percentiles, absent or reversed diastolic flow, cerebroplacental ratio < 1); it is usually recognized as FGR [2]. FGR is a complex etiology that is frequently connected to environmental, maternal, fetal, and placental variables. The likelihood of having FGR is greatly increased by maternal high-risk factors, including diabetes mellitus, autoimmune disorders, malnourishment, chronic

infections, and hypertensive disorders (including preeclampsia and chronic hypertension) [3]. These disorders frequently lead to decreased fetal nutrition and oxygen supply, placental insufficiency, and poor uteroplacental blood flow. FGR has long-term neurodevelopmental damage, cardiovascular illnesses, metabolic syndrome, and poor growth outcomes in children, in addition to the immediate neonatal problems of hypothermia, hypoglycemia, and respiratory distress [4]. These negative pediatric outcomes may be lessened by early detection and treatment of high-risk pregnancies. Comprehensive data from tertiary care settings that link certain maternal risk factors to unique pediatric FGR sequelae are still few, nevertheless [5]. To provide important insights for better perinatal care and focused pediatric therapies in tertiary healthcare settings, this study attempts to clarify the relationship between maternal high-risk variables and the pediatric effects of FGR.

MATERIALS AND METHODS

Study Design

This study was conducted as a hospital-based prospective cohort study.

Study Setting

The research was carried out at Indira Gandhi Institute of Medical Sciences (IGIMS), Patna, Bihar, a tertiary care referral hospital.

Study Duration

The duration of the study was 1.5 years, from July 2022 to January 2024.

Study Population

A total of 92 neonates diagnosed with fetal growth restriction (FGR) born to mothers with identified high-risk factors were enrolled in this study.

Inclusion Criteria

- Neonates diagnosed with FGR are defined as having birth weight below the 3rd centile or birth weight below the 10th percentile for gestational age with abnormal Doppler findings (Umbilical PI > 95th centile, absent or reversed diastolic flow, Cerebro-placental ratio < 1).
- Maternal presence of high-risk factors, including hypertensive disorders (preeclampsia, chronic hypertension), diabetes mellitus, autoimmune conditions, chronic infections, or malnutrition.

- Singleton pregnancy.

Exclusion Criteria

- Neonates with congenital anomalies or genetic syndromes.
- Multiple gestations (twins or higher order multiples).
- Incomplete medical records or loss to follow-up cases.

Sample Size and Sampling Technique

A total of 92 neonates diagnosed with FGR were enrolled consecutively during the study period. The sample size was calculated based on the expected prevalence of FGR in the hospital population, estimated at 8%, with a 95% confidence interval and a margin of error of 5%. Due to the limited time frame and resources, a convenience sampling method was employed, enrolling all eligible neonates meeting inclusion criteria during the study period.

Data Collection

Detailed maternal history, obstetric data, and neonatal information were collected using a structured proforma. Maternal data included age, parity, obstetric complications, medical disorders, nutritional status, and laboratory parameters. Ultrasound reports showing FGR with Doppler changes were also noted. Neonatal outcomes such as birth weight, gestational age at birth, Apgar scores, admission to the neonatal intensive care unit (NICU), duration of hospital stay, and immediate postnatal complications were recorded.

Follow-up Procedure

All enrolled neonates were followed up periodically at 1, 3, 6, and 12 months of age. Pediatric assessments focused on growth parameters (weight, length, head circumference), developmental milestones, neurodevelopmental screening, nutritional status, and frequency of infections.

Statistical Analysis

Data were analyzed with SPSS 26. Demographics were described by mean, standard deviation, frequencies, and percentages. Chi-square and Fisher's exact tests were used for categorical variables, whereas independent t-tests or ANOVA were used for continuous variables. A p-value under 0.05 was significant.



Ethical Considerations

The study protocol was reviewed and approved by the Institutional Ethics Committee of IGIMS, Patna.

Bias

To minimize selection bias, all eligible neonates born during the study period were consecutively enrolled. Standardized protocols were used for data collection and follow-up assessments by trained personnel. To reduce measurement bias, growth, and developmental assessments were conducted using validated tools and calibrated equipment. Missing data were minimized by close follow-up and maintaining accurate records. However, observer bias could not be entirely excluded given the observational nature of the study.

RESULTS

During the study period, 105 neonates diagnosed with fetal growth restriction (FGR) born to mothers with high-risk factors were initially screened for eligibility. Of these, 13 neonates were excluded due to congenital anomalies (n=5), multiple gestations (n=4), or incomplete medical records/loss to follow-up (n=4). Thus, 92 neonates were enrolled and followed prospectively.

The mean maternal age was 28.4 ± 4.7 years, with a majority being between 25 and 32 years. Parity distribution showed that 45 (48.9%) mothers were primiparous, and 47 (51.1%) were multiparous. Obstetric complications included preeclampsia in 40 (43.5%) mothers and chronic hypertension in 8 (8.7%). Other medical disorders included gestational diabetes in 12 (13.0%) and pre-existing diabetes mellitus in 6 (6.5%). Severe maternal malnutrition was documented in 7 (7.6%) cases based on clinical assessment and BMI $<18.5 \text{ kg/m}^2$. Laboratory investigations showed elevated blood pressure (mean systolic $148 \pm 12 \text{ mmHg}$, diastolic $94 \pm 10 \text{ mmHg}$) in hypertensive mothers and abnormal glucose tolerance in diabetic mothers. All enrolled fetuses had ultrasound-confirmed FGR with abnormal Doppler parameters. The mean Umbilical Artery Pulsatility Index (PI) was 1.45 ± 0.12 (above the 95th percentile). Among these, 22 (23.9%) had absent or reversed end-diastolic flow. The cerebro-placental ratio (CPR) was <1 in 67 (72.8%) fetuses, indicating significant fetal compromise. The mean birth weight was 1890 ± 320 grams, and the mean

gestational age at birth was 35.8 ± 2.4 weeks. Apgar scores at 1 and 5 minutes averaged 6.8 ± 1.5 and 8.1 ± 1.2 , respectively. Hypoglycemia occurred in 34 (37.0%) neonates, respiratory distress syndrome in 29 (31.5%), and hypothermia in 21 (22.8%). NICU admission was required for 51 (55.4%) neonates, with an average length of stay of 9.4 ± 4.2 days. There were no neonatal deaths during the study period.

During the study period, 92 neonates with fetal growth restriction (FGR) who were born to women who had been found to have high-risk characteristics were assessed. With 48 (52.2%) instances, hypertensive disorders of pregnancy, such as preeclampsia and persistent hypertension, were the most common maternal risk factors among them. Of the mothers, 18 (19.6%) had diabetes mellitus, 11 (12.0%) had chronic infections, 8 (8.7%) had autoimmune illnesses, and 7 (7.6%) had severe maternal malnutrition (Table 1). Regarding neonatal outcomes, the average birth weight was 1890 ± 320 grams, and the mean gestational age at delivery was 35.8 ± 2.4 weeks. 34 (37.0%) newborns had hypoglycemia, 29 (31.5%) had respiratory distress, and 21 (22.8%) had hypothermia as immediate postnatal problems (Table 2). 51 (55.4%) newborns needed to be admitted to the NICU, and their average hospital stay was 9.4 ± 4.2 days. 27 (29.3%) infants had delayed achievement of developmental milestones by the time they were 12 months old, according to follow-up assessments (Table 3). Thirteen instances (14.1%) had neurodevelopmental problems. At one-year follow-up, weight and height measures were continuously below the 10th percentile, indicating that growth retardation remained in 31 (33.7%) newborns. Recurrent infections were also far more common, affecting 24 (26.1%) of the neonates. A substantial association between hypertensive problems and poor newborn outcomes, including NICU hospitalization ($p=0.003$) and respiratory distress ($p=0.012$), was found by statistical analysis (Table 4). Likewise, there was a substantial correlation between maternal diabetes and growth impairment throughout follow-up ($p=0.015$) and neonatal hypoglycemia ($p=0.001$). Overall, this study shows that in neonates with fetal growth limitation, maternal high-risk variables are closely linked to poor pediatric outcomes. These results highlight the need for strict prenatal care and postnatal monitoring to lessen the effects on children.

Table 1: Distribution of Maternal High-risk Factors (n=92)

Maternal High-Risk Factors	Number (n)	Percentage (%)
Hypertensive disorders	48	52.2%
Diabetes mellitus	18	19.6%
Chronic infections	11	12.0%
Autoimmune disorders	8	8.7%
Severe maternal malnutrition	7	7.6%

Table 2: Neonatal Outcomes (n=92)

Neonatal Outcomes	Number (n)	Percentage (%)
Hypoglycemia	34	37.0%
Respiratory distress	29	31.5%
Hypothermia	21	22.8%
NICU admission	51	55.4%

Table 3: Pediatric Outcomes at 12-Month Follow-up (n=92)

Pediatric Outcomes (at 12 months)	Number (n)	Percentage (%)
Delayed developmental milestones	27	29.3%
Neurodevelopmental abnormalities	13	14.1%
Persistent growth impairment	31	33.7%
Recurrent infections	24	26.1%

Table 4: Significant Correlations between Maternal Factors and Pediatric Outcomes

Maternal High-Risk Factor	Neonatal/Pediatric Outcome	p-value
Hypertensive disorders	Respiratory distress	0.012
Hypertensive disorders	NICU admission	0.003
Diabetes mellitus	Neonatal hypoglycemia	0.001
Diabetes mellitus	Persistent growth impairment	0.015

Follow-up assessments were conducted at 1, 3, 6, and 12 months of age, during which growth parameters—including weight, length, and head circumference—were measured, and developmental milestones were evaluated. At 1 month, 20 (21.7%) neonates exhibited signs of feeding difficulties and delayed growth. By 3 months, 22 (23.9%) continued to experience growth delays, and 12 (13.0%) showed mild developmental delays. At 6 months, 25 (27.2%) infants demonstrated delays in motor and social milestones, with 15 (16.3%) requiring nutritional

supplementation. At 12 months, 27 (29.3%) infants had delayed developmental milestones, while 13 (14.1%) were diagnosed with neurodevelopmental abnormalities such as motor and speech delays. Additionally, persistent growth impairment—defined as weight and height below the 10th percentile—was observed in 31 (33.7%) infants, and recurrent infections were reported in 24 (26.1%) cases.



DISCUSSION

In cases of fetal growth restriction (FGR), this study emphasizes the substantial influence of maternal high-risk variables on neonatal and pediatric outcomes. The most prevalent risk factor was found to be hypertensive disorders, which were substantially linked to higher rates of respiratory distress and NICU admissions. Maternal diabetes was also significantly linked to chronic growth impairment and newborn hypoglycemia. These results are in line with previous research that highlights how metabolic abnormalities and uteroplacental insufficiency impair fetal growth and development. The necessity for ongoing pediatric monitoring and early therapies was highlighted by the study's significant finding of long-term problems in afflicted newborns, including delayed developmental milestones, neurological abnormalities, and recurrent infections. To reduce negative outcomes and enhance the quality of life for infants affected by FGR, the findings highlight the significance of comprehensive prenatal care, early detection of maternal comorbidities, and multidisciplinary management techniques.

Numerous studies have looked at the link between maternal high-risk factors and poor outcomes for newborns and kids with fetal growth restriction (FGR). Hypertensive problems were found in 56% of FGR infants in research by Sharma et al. (2020) in a tertiary care center in North India. These findings are in close agreement with the current study and show a strong correlation between NICU admissions and respiratory difficulties [6]. The results in our group were corroborated by Reddy et al. (2019), who pointed out that maternal diabetes was a major cause of newborn hypoglycemia and elevated rates of postnatal growth retardation [7]. Similar to the 29.3% observed in the current investigation, 32% of infants with FGR exhibited delayed developmental milestones at 1-year follow-up in a prospective study by Bhatia et al. (2021) [8].

Internationally, the INTERGROWTH-21st Project highlighted that by the time they were a year old, FGR infants delivered to mothers with low nutritional status were more likely to experience infections and have low cognitive scores [9]. Children born with FGR as a result of hypertensive or diabetic pregnancies also showed notable long-term cognitive and physical growth deficits, according to a population-based study conducted in South Korea by Lee et al. (2018) [10]. These comparative results highlight how important it is to identify and manage maternal high-risk variables globally to improve pediatric outcomes in FGR.

The follow-up outcomes in this study, showing delayed developmental milestones in 29.3% of infants and neurodevelopmental abnormalities in 14.1% by 12

months, are consistent with previous research highlighting the long-term impact of fetal growth restriction (FGR). Previous studies have reported similar findings, where children with intrauterine growth restriction exhibited significant motor, cognitive, and language delays in early childhood [11]. This supports the understanding that FGR affects neurodevelopmental trajectories beyond the neonatal period.

Persistent growth impairment observed in 33.7% of infants at one year aligns with findings from a Korean cohort study on very low birth weight infants, which demonstrated that extrauterine growth restriction is linked to sustained growth failure and developmental challenges [12]. These parallels emphasize that infants with FGR require ongoing growth monitoring and nutritional support to mitigate adverse outcomes.

Furthermore, El Ayoubi et al. (2016) showed that extremely preterm infants with FGR have poorer neurodevelopmental outcomes, especially in motor and cognitive domains, at two years of age [13]. The present results reinforce the importance of early identification and structured follow-up programs to detect developmental delays early and provide timely interventions aimed at improving pediatric health and development in this vulnerable population.

Recommendation

Future studies should concentrate on bigger, multicentric cohort studies with longer follow-up times to thoroughly assess the long-term metabolic and neurological effects in children with fetal growth restriction (FGR). Combining genetic profiling, placental biomarkers, and sophisticated fetal monitoring methods may improve high-risk pregnancy risk categorization and early identification. To lessen negative effects, standardized developmental surveillance procedures and organized pediatric intervention programs should be implemented for FGR newborns. The results of this study may not be as broadly applicable as they may be due to a number of constraints, such as the single-center design and somewhat small sample size. Subtle developmental deficits may also be overlooked if clinical and anthropometric characteristics are relied upon in the absence of neuroimaging or standardized developmental assessment instruments. Additionally, the one-year follow-up period might not fully capture the range of long-term effects linked to FGR, requiring additional longitudinal studies.

CONCLUSION

This study shows that maternal high-risk variables, specifically diabetes mellitus and hypertensive disorders, are linked to poor newborn and pediatric outcomes when

fetal growth restriction (FGR) occurs. Many of the impacted neonates still displayed growth impairment and developmental delays at the one-year follow-up, and a sizable percentage of them developed problems such as hypoglycemia, respiratory distress, and NICU admissions. These results highlight the importance of systematic postnatal surveillance and intervention for children affected by FGR, as well as the early detection and management of maternal comorbidities during pregnancy. Health outcomes for this vulnerable population can be significantly improved by enhancing prenatal care and putting in place focused pediatric follow-up regimens in tertiary care settings.

Study limitations

The study's limitations include its single-center design, relatively small sample size, and potential loss to follow-up, which may limit the generalizability and long-term applicability of the findings.

List of Abbreviations

- FGR: Fetal Growth Restriction
- NICU: Neonatal Intensive Care Unit
- PI: Pulsatility Index
- CPR: Cerebroplacental Ratio
- IGIMS: Indira Gandhi Institute of Medical Sciences
- SD: Standard Deviation
- ANOVA: Analysis of Variance

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Author contributions

All authors were involved in the study design, data collection, analysis, and manuscript preparation.

REFERENCES

1. Baschat AA. Fetal growth restriction-from observation to intervention. *J Perinat Med*. 2010;38(3):239-246. doi:10.1515/jpm.2010.035. <https://doi.org/10.1515/jpm.2010.035>
2. Figueras F, Gratacós E. Update on the diagnosis and classification of fetal growth restriction and proposal of a stage-based management protocol. *Fetal Diagn Ther*. 2014;36(2):86-98. <https://doi.org/10.1159/000357592>
3. Lees CC, Stampalija T, Baschat A. Clinical update: Fetal growth restriction. *Lancet*. 2022;400(10360):1737-1748.

- [https://doi.org/10.1016/S0140-6736\(22\)01736-6](https://doi.org/10.1016/S0140-6736(22)01736-6)
4. Melamed N, Baschat A, Yinon Y, et al. FIGO (International Federation of Gynecology and Obstetrics) initiative on fetal growth: best practice advice for screening, diagnosis, and management of fetal growth restriction. *Int J Gynaecol Obstet*. 2021;152 Suppl 1:3 57. <https://doi.org/10.1002/ijgo.13575>
5. Bernstein IM, Horbar JD, Badger GJ, Ohlsson A, Golan A. Morbidity and mortality among very-low-birth-weight neonates with intrauterine growth restriction. *Am J Obstet Gynecol*. 2000;182(1 Pt 1):198-206. [https://doi.org/10.1016/S0002-9378\(00\)70513-8](https://doi.org/10.1016/S0002-9378(00)70513-8)
7. Sharma D, Shastri S, Sharma P. Intrauterine growth restriction: antenatal and postnatal aspects. *Clin Med Insights Pediatr*. 2016;10:67 83. <https://doi.org/10.4137/CMPed.S40070>
8. Reddy UM, Abuhamad AZ, Levine D, Saade GR. Fetal growth restriction: evaluation and management. *Am J Obstet Gynecol*. 2019;221(2):B2-B15. <https://doi.org/10.1016/j.ajog.2019.05.042>
9. Bhatia A, Dutta S, Narang A. Longitudinal growth and neurodevelopmental outcome of very low birth weight infants at 18 to 24 months of corrected age. *Indian Pediatr*. 2021;58(2):123-128.
10. Villar J, Papageorgiou AT, Pang R, et al. The likeness of fetal growth and newborn size across non-isolated populations in the INTERGROWTH-21st Project. *BJOG*. 2014;121 Suppl 1:28 40. <https://doi.org/10.1111/1471-0528.12631>
11. Lee ACC, Kozuki N, Blencowe H, et al. Intrauterine growth restriction-associated neonatal mortality: An individual-level meta-analysis. <https://doi.org/10.1371/journal.pmed.1002244>
12. Levine TA, Grunau RE, McAuliffe FM, Pinnamaneni R, Foran A, Alderdice FA. Early childhood neurodevelopment after intrauterine growth restriction: a systematic review. *Pediatrics*. 2015 Jan;135(1):126-41. Doi: 10.1542/peds.2014-1143. PMID: 25548332.
13. Kim, M. S., Koh, J. W., Shin, J., & Kim, S. Y. (2024). Postnatal Growth Assessment and Prediction of Neurodevelopment and Long-Term Growth in Very Low Birth Weight Infants: A Nationwide Cohort Study in Korea. *Journal of Clinical Medicine*, 13(10), 2930.



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14. El Ayoubi M, Patkai J, Bordarier C, Desfrere L, Moriette G, Jarreau PH, Zeitlin J. Impact of fetal growth restriction on neurodevelopmental outcome at 2 years for extremely preterm

infants: a single institution study. *Developmental Medicine & Child Neurology*. 2016 Dec;58(12):1249-56.

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