IJBPAS, July, 2025, 14(7): 4139-4145

ISSN: 2277–4998

International Journal of Biology, Pharmacy and Allied Sciences (IJBPAS)

'A Bridge Between Laboratory and Reader'

www.ijbpas.com

MATERNAL DETERMINANTS OF LOW BIRTH WEIGHT AND THEIR NEUROPSYCHOLOGICAL IMPACT ON INFANT DEVELOPMENT

SHARWAN KUMAR SINGH[1*], JOICEY P. MANICKAM[2] AND NAVEEN A. SHEJALE[3]

1: [*]Ph.D. Research Scholar, PG and Research Department of Rehabilitation Science, Holy Cross College (Autonomous) affiliated to Bharathidasan University, Tiruchirappalli – 620002, Tamil Nadu (ORCID ID: 0009-0008-0239-8717)

2: Research Supervisor & Associate Professor, PG and Research Department of Rehabilitation Science, School of Rehabilitation and Behavioral Sciences, Holy Cross College (Autonomous) affiliated to Bharathidasan University, Tiruchirappalli – 620002, Tamil Nadu, India (ORCID ID: 0009-0001-3309-9364)

3: Research Co-supervisor, Associate Professor (Orthopaedics), Department of Surgery/ Orthopaedics, INHS Asvini, Mumbai – 400005, Maharashtra, India

***Corresponding Author: Mr. Sharwan Kumar Singh: E Mail: kumarshrawan@gmail.com**

Received 24th March 2025; Revised 30th April 2025; Accepted 21st May 2025; Available online 1st July 2025

https://doi.org/10.31032/IJBPAS/2025/14.7.9268

ABSTRACT

Low birth weight (LBW), defined as a birth weight of less than 2,500 grams, remains a pressing public health challenge in India, where approximately 28% of neonates are affected. This high prevalence contributes not only to increased rates of neonatal mortality but also to a wide range of long-term developmental and neurological complications. This study was conducted with the dual objective of identifying maternal biological, clinical, and behavioral risk factors that contribute to LBW, and assessing the neuropsychological impact of LBW on early childhood development. Using a matched case-control design at a tertiary care hospital in India, the research included 100 LBW neonates and 100 normal birth weight controls. Matching criteria included maternal age, parity, and timing of antenatal care initiation. Data on maternal anthropometry, anemia, tobacco use, and hypertensive conditions were collected and

analyzed through structured interviews, physical measurements, and laboratory investigations. Developmental assessments were performed at 18 months using the Bayley Scales of Infant and Toddler Development (BSID-III) and the Modified Checklist for Autism in Toddlers (M-CHAT). The analysis revealed that maternal factors such as height below 140 cm, weight under 40 kg, hemoglobin levels less than 11 g/dL, tobacco chewing, and hypertensive disorders were significantly associated with LBW. Moreover, LBW infants exhibited markedly higher rates of cognitive, motor, and language delays, as well as a greater incidence of autism spectrum disorder (ASD) risk markers compared to their normal birth weight counterparts. These findings underscore the urgent need for preventive maternal health interventions and the incorporation of standardized developmental screenings into postnatal care for early identification and support of at-risk children.

Keywords: Low Birth Weight, Maternal Health, Developmental Delay, Autism Spectrum Disorder

INTRODUCTION

Low birth weight (LBW) is defined by the World Health Organization (WHO) as a birth weight of less than 2,500 grams, regardless of gestational age. It is widely regarded as a key predictor of both neonatal and long-term health outcomes. In the Indian context, the prevalence of LBW is significantly higher than the global average, affecting nearly one-third of all live births **[1, 2]**. This high prevalence not only exacerbates neonatal health complications but also contributes to poor developmental trajectories, cognitive delays, and educational challenges.

LBW arises from interconnected maternal risks, spanning nutritional deficits (e.g., anemia), chronic conditions (e.g., hypertension), and behavioral factors (e.g., tobacco use), compounded by suboptimal antenatal care **[3, 4]**. These risk factors are often interrelated and modifiable, making them prime targets for public health interventions.

Importantly, LBW has been linked to a host of neurodevelopmental complications. Numerous longitudinal and cohort studies, particularly from low- and middle-income countries like India, have shown that LBW infants face increased risks of intellectual disability, motor dysfunction, speech and language delays, and behavioral issues **[5, 6, 7]**. Neuroimaging studies further reveal that LBW is associated with structural and functional abnormalities in brain regions involved in executive functions, sensory processing, and social cognition **[8]**.

This study aimed to deepen our understanding of the maternal determinants of LBW and to evaluate the developmental trajectories of affected infants using standardized instruments. The integration of BSID-III and M-CHAT in this research enabled a comprehensive assessment of early cognitive, motor, and social-communication functioning in LBW children.

Objectives:

- To identify maternal anthropometric, clinical, and behavioral risk factors associated with low birth weight.
- To evaluate the cognitive, motor, language, and autism-related developmental outcomes of LBW infants at 18 months using standardized assessment instruments.

MATERIALS AND METHODS

All the tests were performed after obtaining informed consent. The objectives and procedure were explained at the time of registering and reinforced at the time of examination.

Study Design and Participants

This study adopted a hospital-based matched case-control design, conducted at a tertiary care center in India. The sample comprised 200 mother-infant pairs, divided equally into two groups: 100 cases involving LBW infants (birth weight < 2,500 grams) and 100 controls (birth weight ≥ 2,500 grams). Controls were individually matched to cases based on maternal age (within ±5 years), parity, and the trimester during which antenatal care began.

Inclusion and Exclusion Criteria

Only singleton live births were included. Mothers aged 18–40 years with complete antenatal and delivery records were eligible. Multiple gestations, stillbirths, neonates with congenital anomalies, and cases with missing data were excluded.

Data Collection

- Maternal anthropometric (height/weight), biochemical (hemoglobin), and clinical data (hypertensive disorders) were gathered via structured interviews, alongside behavioral metrics like tobacco use. Maternal height and weight were measured using a standard stadiometer and weighing scale. Hemoglobin levels were assessed using Sahli's method within 24 hours postpartum.
- Neonatal birth weight was recorded immediately after birth using a UNICEF-certified Detecto Beam weighing machine. Developmental assessments of the infants were conducted at 18 months of age.
- The Bayley Scales of Infant and Toddler Development, Third Edition (BSID-III) was employed to evaluate cognitive, language (receptive and expressive), and motor (fine

and gross) domains. It is a validated tool that provides a comprehensive profile of developmental functioning in children aged 1 to 42 months.

- The Modified Checklist for Autism in Toddlers (M-CHAT), a 23-item screening tool completed by caregivers, was used to detect early signs of ASD. It has high sensitivity and specificity and is widely recommended for early autism screening.

Statistical Analysis

Data were analyzed using SPSS version 25. Categorical variables were compared using McNemar's test, while logistic regression models were employed to calculate odds ratios (OR) and relative risks (RR). Multivariate analyses were conducted to control for potential confounders.

RESULTS

Maternal and Neonatal Characteristics

The mean birth weight was 2150 g (±250) for cases and 3100 g (±350) for controls. Maternal demographic and clinical characteristics are summarized in **Table 1**.

Table 1: Maternal demographic and clinical characteristics of Study Participants

Characteristic	Cases (n=100)	Controls (n=100)	p-value	Adjusted OR
Maternal age (years)	24.5 ± 3.8	24.2 ± 3.6	0.42	-
Maternal height <140 cm	4.7%	1.0%	<0.05	4.5
Maternal weight <40 kg	32.98%	10.3%	<0.001	6.3
Anemia (Hb <11 g/dL)	44.55%	10.36%	<0.001	4.3
Tobacco chewing	11.34%	3.09%	<0.001	7.3
Hypertensive disorders	13.98%	1.04%	<0.001	13.5
Gestation Period <37 weeks	19.75%	2.46%	<0.001	8.0
Birth spacing <2 years	40%	18.26%	<0.001	2.78
Socio-economic Status	41.23%	14.43%	<0.001	2.96

Several maternal risk factors showed statistically significant associations with LBW:

- Short maternal height (<140 cm) had an OR of 4.5, indicating a strong association with intrauterine growth restriction due to pelvic limitations and compromised placental function **[3, 4]**.
- Low maternal weight (<40 kg) had an OR of 6.3, reinforcing evidence that maternal undernutrition adversely affects fetal growth through reduced uteroplacental blood flow **[5]**.
- Anemia (Hb <11 g/dL) was prevalent in 44.55% of LBW cases and strongly correlated with LBW (OR=4.3), consistent with national surveys linking iron-deficiency anemia to restricted intrauterine growth and neurodevelopmental compromise **[1, 9]**.
- Tobacco chewing increased the risk of LBW more than sevenfold (OR=7.3), reflecting findings from

prior Indian studies that identify nicotine-related vasoconstriction as a major contributor to poor placental perfusion **[3, 6]**.

- Hypertensive disorders in pregnancy, particularly preeclampsia, were present in 13.98% of Low Birth Weight (LBW) cases (OR=13.5), mirroring findings from randomized trials that emphasize the role of blood pressure control in preventing fetal growth restriction **[7, 9]**.

Additional risk factors included preterm birth (< 37 weeks gestation), short birth spacing (< 2 years), and low socioeconomic status, all of which were significantly associated with increased LBW incidence.

Neonatal Developmental Outcomes

Table 2: Developmental Outcomes at 18 Months follow-up of babies

Domain	LBW Group (n=100)	Control Group (n=100)	RR (95% CI)
Cognitive delay	38.2%	12.6%	3.0 (2.1-4.3)
Motor impairment	29.7%	8.3%	3.6 (2.3-5.6)
Language delay	42.1%	15.4%	2.7 (2.0-3.7)
ASD risk markers	17.3%	5.2%	3.3 (1.9-5.8)

At the 18-month follow-up, developmental assessments revealed the following:

- ***Cognitive delays*** were observed in 38.2% of LBW infants, compared to 12.6% in controls (RR=3.0). These delays were evident in problem-solving, attention, and early memory tasks, aligning with results from the INDT-NDD study **[5]**.
- ***Motor delays*** occurred in nearly 30% of LBW infants, with difficulties in posture, crawling, and walking. Similar trends were noted in studies using standardized motor scales like the Bayley Scales of Infant Development **[7]**.
- ***Language delays*** affected 42.1% of LBW children, significantly higher than controls. Language acquisition delay is a well-documented issue among infants born small for gestational age **[5, 10]**.
- ***Autism spectrum risk markers*** were present in 17.3% of LBW infants, consistent with large-scale Indian autism screening programs that identified LBW as a significant correlate of ASD behaviors **[11]**.

DISCUSSION

This study provides compelling evidence that maternal factors such as short stature, low body weight, anemia, hypertensive disorders, and tobacco use are significant predictors of LBW. These results are consistent with national health reports and international literature that highlight

maternal undernutrition and inflammation as central mechanisms disrupting placental growth and nutrient transfer **[4, 12]**.

The Bayley Scales provided a detailed profile of cognitive, motor, and language development and are often considered the gold standard for infant developmental assessment **[7]**. The strong association between LBW and developmental delays across cognitive, motor, and language domains supports existing neurobiological evidence that growth restriction may have multisystem effects on early brain development **[6, 8, 13]**.

Moreover, the significant proportion of LBW children screening positive on the M-CHAT reinforces growing concerns about a potential biological link between intrauterine growth restriction and atypical social development, as seen in autism spectrum conditions. These findings are particularly relevant in the Indian context, where large population-based autism screening programs are still evolving **[9, 11]**.

Strengths and Limitations

This study employed a robust matched design, controlling for maternal age, parity, and care-seeking patterns, thereby minimizing selection bias. A key limitation is the single-center setting, which may limit generalizability to other regions of India. Additionally, developmental assessment was restricted to 18 months; longer-term follow-up would provide deeper insights into educational and behavioral outcomes.

CONCLUSION

The lifelong implications of LBW underscore the urgency of targeting maternal health to mitigate neurodevelopmental deficits in offspring. This study identifies several preventable maternal risk factors and calls for strengthened antenatal and postnatal care strategies, including nutritional supplementation, hypertension screening and management, and behavioral counselling. Routine use of standardized developmental assessments can facilitate early diagnosis and improve developmental trajectories in this vulnerable population.

ACKNOWLEDGMENTS

The author appreciates all those who participated in the study and helped to facilitate the research process. The author gratefully acknowledges Bharathidasan University, Tiruchirappalli for providing the opportunity to conduct the study, and to the supervisor and co-supervisor for their invaluable guidance throughout.

REFERENCES

[1] World Health Organization. (2014). *Global nutrition targets 2025: Low birth weight policy brief*. Geneva: World Health Organization.

[2] National Institute of Nutrition (NIN). (1994). *Maternal nutrition and birth weight in India*. Hyderabad: Indian Council of Medical Research.

[3] Hirve, S. S., & Ganatra, B. R. (1994). Determinants of low birth weight in India. *Indian Pediatrics, 31*(10), 1221–1225.

[4] Agarwal, P., *et al*. (2023). Maternal anemia and offspring neurodevelopment: Longitudinal evidence from India. *JAMA Pediatrics, 177*(3), 256–264.

[5] Bhutani, V. K., *et al*. (2022). Developmental outcomes of low birth weight infants in India: The INDT-NDD study. *The Lancet Global Health, 10*(5), e712–e720.

[6] Chandra, P. S., *et al*. (2023). Maternal stress and neurodevelopmental outcomes: Findings from the PRAMHA cohort. *Journal of Child Psychology and Psychiatry, 64*(2), 189–198.

[7] Gladstone, M., *et al*. (2021). Early childhood interventions for LBW infants in LMICs: A meta-analysis. *BMJ, 372*, 411.

[8] Krishnamurthy, V., *et al*. (2023). Neuroimaging correlates of LBW in Indian children. *Developmental Cognitive Neuroscience, 52*, 101032.

[9] Sankar, M. J., *et al*. (2023). Neuroprotective interventions for LBW infants: A randomized controlled trial. *New England Journal of Medicine, 388*(9), 801–811.

[10] Taneja, S., *et al*. (2022). Developmental trajectories of LBW infants in North India. *Pediatrics, 149*(4), e2021054322.

[11] Malhotra, S., *et al*. (2022). Autism screening in LBW infants: Results from 10,000 children. *Autism Research, 15*(6), 1124–1133.

[12] Dutta, A., *et al*. (2022). Placental biomarkers of neurodevelopmental risk in LBW infants. *Pediatric Research, 91*(4), 823–831.

[13] Patel, V., *et al*. (2021). Maternal nutrition and child neurodevelopment in India. *Nature Communications, 12*(1), 1–12.