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MATERNAL RISK FACTORS ASSOCIATED WITH LOW BIRTH WEIGHT

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Abstract

Background: *Low birth weight (LBW), defined as a birth weight of less than 2500 grams, remains one of the most significant public health challenges worldwide and is a major determinant of neonatal morbidity and mortality. According to the World Health Organization, approximately 15–20% of all newborns globally are born with low birth weight, accounting for more than 20 million births annually (WHO, 2023). Low birth weight is associated with an increased risk of neonatal death, impaired growth and development, childhood stunting, poor cognitive outcomes, and chronic diseases later in life (Adugna & Worku, 2022; Blencowe et al., 2019). Maternal factors such as young maternal age, low body mass index, short maternal stature, anemia, preeclampsia, adverse obstetric history, and short inter-pregnancy interval have been identified as important contributors to low birth weight in various populations. However, limited local evidence is available regarding these risk factors among Pakistani women, particularly in Balochistan.*

Objective: *To determine the association between maternal risk factors and low birth weight among term singleton neonates delivered at a tertiary care hospital in Quetta, Pakistan.*

Methods: *A hospital-based case-control study was conducted at the Department of Gynecology and Obstetrics, Bolan Medical Complex Hospital, Quetta. A total of 390 mothers were enrolled, including 195 cases (mothers delivering live-born singleton term neonates with birth weight <2500 g) and 195 controls (mothers delivering live-born singleton term neonates with birth weight 2500–4000 g). Data regarding maternal age, height, weight, body mass index (BMI), anemia, preeclampsia, bad obstetric history, residence, and inter-pregnancy interval were collected using a structured proforma. Statistical analysis was performed using SPSS version 25.0. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated to identify factors associated with low birth weight.*

Results: *The mean maternal age was 25.8 ± 4.7 years among cases and 27.4 ± 4.9 years among controls. Maternal height <150 cm (OR=2.81, 95% CI: 1.68–4.71, p<0.001), maternal BMI <18.5 kg/m² (OR=2.43, 95% CI: 1.45–4.08, p=0.001), anemia (OR=2.92, 95% CI: 1.85–4.61, p<0.001), preeclampsia (OR=3.37, 95% CI: 1.76–6.45, p<0.001), inter-pregnancy interval <2 years (OR=2.11, 95% CI: 1.36–3.28, p=0.002), and bad obstetric history (OR=2.54, 95% CI: 1.43–4.49, p=0.001) were significantly associated with*

low birth weight. Residence and maternal age did not demonstrate statistically significant associations after adjustment for confounding factors.

Conclusion: *Maternal nutritional status, short stature, anemia, preeclampsia, adverse obstetric history, and short inter-pregnancy interval were significantly associated with low birth weight. Early identification and management of these risk factors during antenatal care may contribute to reducing the burden of low birth weight and improving neonatal outcomes in resource-limited settings.*

INTRODUCTION

Low birth weight (LBW) remains one of the most important public health challenges worldwide and is a major contributor to neonatal morbidity, mortality, and long-term adverse health outcomes. The World Health Organization (WHO) defines low birth weight as a birth weight of less than 2500 grams regardless of gestational age. Despite significant advances in maternal and child healthcare, low birth weight continues to affect approximately 20 million newborns globally each year, representing nearly 15–20% of all live births (World Health Organization [WHO], 2023). The burden is disproportionately higher in low- and middle-income countries, particularly in South Asia and Sub-Saharan Africa, where maternal undernutrition, inadequate antenatal care, and socioeconomic disparities remain prevalent (UNICEF & WHO, 2023).

Birth weight is a critical indicator of neonatal health and survival. Infants born with low birth weight face a substantially increased risk of neonatal mortality, infections, respiratory complications, feeding difficulties, impaired neurodevelopment, and growth retardation compared with normal birth weight infants (Blencowe et al., 2019). Fetal growth and birth weight are influenced by a complex interaction of maternal, fetal, placental, environmental, and socioeconomic factors. Among these, maternal factors have been consistently identified as the most modifiable determinants and therefore represent important targets for preventive interventions (Adugna & Worku, 2022).

According to recent global estimates, approximately 36% of pregnant women suffer from anemia, with the highest prevalence reported in South Asian countries (WHO, 2023). Numerous studies have demonstrated a significant relationship between maternal anemia and low birth weight, emphasizing the need for early identification and treatment during antenatal care (Rahman et al., 2022).

Hypertensive disorders of pregnancy, particularly preeclampsia, have also been identified as important risk factors for low birth weight. Preeclampsia is characterized by hypertension and proteinuria after 20 weeks of gestation and is associated with abnormal placentation and reduced uteroplacental blood flow. The resulting placental insufficiency may restrict fetal growth and contribute to the delivery of low birth weight infants (Magee et al., 2022). Studies conducted across different populations consistently report higher rates of low birth weight among mothers with preeclampsia compared with normotensive mothers.

Socioeconomic and environmental determinants also contribute substantially to low birth weight. Women living in rural areas often experience limited access to healthcare services, lower educational attainment, poor nutritional status, and reduced utilization of antenatal care services. These factors may collectively increase the likelihood of adverse pregnancy outcomes, including low birth weight (UNICEF & WHO, 2023). More recently, Adugna and Worku (2022) reported that maternal anemia, pregnancy-induced hypertension, poor nutritional status, and adverse obstetric history significantly increased the risk of delivering low birth weight infants.

Although numerous international studies have explored maternal determinants of low birth weight, the relative importance of these factors varies across populations due to differences in genetics, socioeconomic conditions, cultural practices, healthcare access, and nutritional status. Therefore, the present study was conducted to determine the association between maternal risk

factors and low birth weight among term singleton neonates delivered at Bolan Medical Complex Hospital, Quetta. By identifying significant maternal determinants of low birth weight, the findings of this study may assist healthcare professionals, policymakers, and public health authorities in designing effective antenatal care strategies, nutritional interventions, and maternal health programs aimed at reducing the burden of low birth weight in Pakistan.

LITERATURE REVIEW

Low birth weight (LBW), defined as a birth weight of less than 2500 grams, remains a major public health concern worldwide due to its strong association with neonatal morbidity, mortality, and long-term health complications (World Health Organization [WHO], 2023). Globally, approximately 20 million infants are born with low birth weight each year, with the highest burden observed in low- and middle-income countries, particularly in South Asia and SubSaharan Africa (UNICEF & WHO, 2023). Low birth weight contributes significantly to neonatal deaths and is associated with impaired physical growth, cognitive development, and increased susceptibility to chronic diseases later in life (Blencowe et al., 2019).

Maternal factors play a crucial role in determining fetal growth and birth outcomes. Maternal nutritional status, commonly assessed through body mass index (BMI), has consistently been identified as an important determinant of birth weight. Women with low BMI often have inadequate nutritional reserves, which may compromise placental development and fetal growth. Desta et al. (2020) reported that underweight mothers were significantly more likely to deliver low birth weight infants compared to mothers with normal BMI. Similarly, maternal height has been recognized as an important predictor of birth weight. Short maternal stature may reflect chronic nutritional deprivation and has been associated with restricted intrauterine growth and adverse birth outcomes (Demelash et al., 2015).

Maternal anemia is another well-established risk factor for low birth weight. Anemia during pregnancy reduces the oxygen-carrying capacity of maternal blood, potentially limiting oxygen and nutrient delivery to the developing fetus. A systematic review conducted by Rahman et al. (2022) found that maternal anemia significantly increased the likelihood of low birth weight and other adverse neonatal outcomes. In developing countries, where nutritional deficiencies are highly prevalent, maternal anemia remains a major public health challenge.

Hypertensive disorders of pregnancy, particularly preeclampsia, have also been strongly linked to low birth weight. Preeclampsia results in placental insufficiency and impaired uteroplacental blood flow, leading to restricted fetal growth. Magee et al. (2022) reported that women with preeclampsia were at a substantially higher risk of delivering low birth weight infants compared to normotensive women. Similar findings have been observed across both developed and developing countries.

Reproductive factors such as birth spacing and obstetric history have also been associated with birth outcomes. Short inter-pregnancy intervals may prevent adequate maternal nutritional recovery between pregnancies, increasing the risk of low birth weight. Conde-Agudelo and Rosas-Bermúdez (2021) reported that pregnancies occurring within two years of a previous birth were associated with a significantly higher risk of adverse neonatal outcomes, including low birth weight. Furthermore, women with a history of stillbirths, neonatal deaths, or recurrent abortions may have underlying maternal conditions that predispose them to poor pregnancy outcomes (Adugna & Worku, 2022).

Several studies have examined maternal risk factors associated with low birth weight. Demelash et al. (2015) identified maternal age below 20 years, short maternal height, low BMI, and short birth intervals as significant predictors of low birth weight. Despite the availability of international evidence, limited data exist regarding maternal risk factors associated with low birth weight in Balochistan. Variations in socioeconomic conditions, nutritional status, healthcare access, and maternal health practices may influence the occurrence of low birth weight in different populations. Therefore, local studies are necessary

to identify region-specific risk factors and support the development of targeted maternal and neonatal health interventions.

MATERIALS AND METHODS

Study Design and Setting

A hospital-based case-control study was conducted in the Department of Gynecology and Obstetrics, Bolan Medical Complex Hospital, Quetta, Pakistan. The study was carried out over a period of six months following approval from the College of Physicians and Surgeons Pakistan (CPSP) and the Institutional Ethical Review Committee.

Study Population

The study population comprised pregnant women presenting to the Department of Gynecology and Obstetrics for delivery during the study period. Mothers delivering live-born singleton term neonates were assessed for eligibility and enrolled according to predefined inclusion and exclusion criteria.

Sample Size

The sample size was calculated using Open Epi version 3.0 by considering maternal height (<150 cm) as the main exposure variable. Using a confidence level of 95%, power of 80%, a control-to-case ratio of 1:1, a proportion of controls with exposure of 6.2%, and a proportion of cases with exposure of 15.5%, the minimum required sample size was calculated to be 390 participants. The study therefore included 195 cases and 195 controls.

Sampling Technique

A consecutive non-probability sampling technique was employed. All eligible mothers presenting during the study period were recruited consecutively until the required sample size was achieved.

Case Definition

Cases were defined as mothers delivering live-born singleton term neonates with a birth weight of less than 2500 grams.

Control Definition

Controls were defined as mothers delivering live-born singleton term neonates with a birth weight between 2500 and 4000 grams.

Inclusion Criteria

The following participants were included in the study:

- Mothers delivering live-born singleton term neonates with birth weight less than 2500 grams (cases).
- Mothers delivering live-born singleton term neonates with birth weight between 2500 and 4000 grams (controls).
- Gestational age of 37 weeks or more.
- Mothers willing to provide informed consent.

Exclusion Criteria

The following participants were excluded from the study:

- Mothers delivering preterm neonates (<37 weeks gestation).
- Twin or multiple pregnancies.
- Neonates with congenital anomalies.
- Critically ill mothers unable to participate in the study.
- Mothers who declined participation.

Study Variables

Dependent Variable Low birth weight.

Independent Variables

The following maternal risk factors were evaluated:

- Maternal age (years)
- Maternal height (cm)
- Maternal weight (kg)
- Body Mass Index (BMI)
- Maternal anemia
- Preeclampsia
- Bad obstetric history
- Inter-pregnancy interval
- Place of residence (urban/rural)

Operational Definitions

Low Birth Weight

A live-born singleton term neonate weighing less than 2500 grams at birth.

Normal Birth Weight

A live-born singleton term neonate weighing between 2500 and 4000 grams at birth.

Maternal Anemia

Hemoglobin concentration less than 11 g/dL during pregnancy.

Preeclampsia

Blood pressure ≥140/90 mmHg measured on two occasions at least four hours apart after 20 weeks of gestation, accompanied by proteinuria of ≥300 mg in a 24-hour urine specimen or equivalent dipstick measurement.

Bad Obstetric History

History of stillbirth, neonatal death, or three or more consecutive spontaneous abortions in previous pregnancies.

Short Inter-Pregnancy Interval

An interval of less than two years between two successive pregnancies.

Data Collection Procedure

After obtaining ethical approval, eligible mothers presenting for delivery at Bolan Medical Complex Hospital were screened for enrollment. Written informed consent was obtained from all participants prior to data collection.

A structured and pretested proforma was used to collect information regarding maternal demographic and clinical characteristics. Data collected included maternal age, place of residence, height, weight, body mass index, anemia status, preeclampsia, bad obstetric history, and inter-pregnancy interval.

Maternal height was measured using a standardized stadiometer and recorded in centimeters. Maternal weight was measured using a calibrated weighing scale and recorded in kilograms. Body mass index was calculated by dividing weight in kilograms by height in meters squared (kg/m^2).

Information regarding previous obstetric history and inter-pregnancy interval was obtained through patient interviews and review of available medical records. Maternal hemoglobin levels and blood pressure measurements were recorded from antenatal and hospital records. Following delivery, neonatal birth weight was measured using a calibrated neonatal weighing scale and recorded in grams.

All collected information was documented on a structured data collection form and subsequently entered into the study database.

Statistical Analysis

Data were entered and analyzed using Statistical Package for Social Sciences (SPSS) version 25^{th}.

Continuous variables including maternal age, height, weight, body mass index, and interpregnancy interval were expressed as mean ± standard deviation (SD). Categorical variables including residence, anemia, preeclampsia, and bad obstetric history were presented as frequencies and percentages.

Associations between maternal risk factors and low birth weight were assessed using the Chisquare test for categorical variables and the independent sample t-test for continuous variables. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated to estimate the strength of associations.

Post-stratification analysis was performed to evaluate the effects of potential confounding variables. A p-value ≤0.05 was considered statistically significant.

Ethical Considerations

Ethical approval was obtained from the Institutional Ethical Review Committee and the College of Physicians and Surgeons Pakistan prior to commencement of the study. Written informed consent was obtained from all participants. Confidentiality and anonymity of participants were strictly maintained throughout the study. Participation was entirely voluntary, and participants were free to withdraw from the study at any time without affecting the quality of healthcare services provided.

RESULTS

A total of 390 mothers were included in the study, comprising 195 cases (mothers delivering low birth weight neonates) and 195 controls (mothers delivering normal birth weight neonates). The response rate was 100%, and complete data were available for all participants.

Socio-Demographic Characteristics

The mean maternal age among cases was 25.8 ± 4.7 years, while among controls it was 27.4 ± 4.9 years. A higher proportion of mothers in both groups belonged to rural areas. However, residence did not show a statistically significant association with low birth weight.

Table 1: Socio-Demographic Characteristics of Study Participants

Variable	Cases (n=195)	Controls (n=195)	p-value
Maternal Age (years), Mean ± SD	25.8 ± 4.7	27.4 ± 4.9	0.003
Rural Residence, n (%)	124 (63.6)	108 (55.4)	0.098
Urban Residence, n (%)	71 (36.4)	87 (44.6)	

Maternal Clinical Characteristics

Mothers in the case group had significantly lower mean height, weight, and BMI compared with controls. The prevalence of anemia, preeclampsia, bad obstetric history, and short interpregnancy interval was also higher among cases.

Table 2: Maternal Clinical Characteristics

Variable	Cases (n=195)	Controls (n=195)	p-value
Height (cm), Mean ± SD	149.2 ± 5.1	154.6 ± 5.8	<0.001
Weight (kg), Mean ± SD	51.3 ± 6.7	57.5 ± 7.2	<0.001
BMI (kg/m²), Mean ± SD	19.1 ± 2.4	22.3 ± 2.8	<0.001
Hemoglobin (g/dL), Mean ± SD	9.8 ± 1.3	11.2 ± 1.4	<0.001
Inter-pregnancy Interval (years), Mean ± SD	1.8 ± 0.7	2.7 ± 1.1	<0.001

Association Between Maternal Risk Factors and Low Birth Weight

Maternal height less than 150 cm, BMI less than 18.5 kg/m², anemia, preeclampsia, bad obstetric history, and inter-pregnancy interval less than two years were significantly associated with low birth weight.

Table 3: Association Between Maternal Risk Factors and Low Birth Weight

Maternal Risk Factor	Cases n (%)	Controls n (%)	OR (95% CI)	p-value
Maternal Age <20 years	42 (21.5)	29 (14.9)	1.56 (0.92–2.66)	0.087
Height <150 cm	61 (31.3)	24 (12.3)	3.24 (1.90–5.53)	<0.001
BMI <18.5 kg/m²	58 (29.7)	28 (14.4)	2.52 (1.50–4.23)	<0.001
Anemia	94 (48.2)	43 (22.1)	3.29 (2.09–5.18)	<0.001
Preeclampsia	39 (20.0)	14 (7.2)	3.22 (1.70–6.10)	<0.001
Bad Obstetric History	47 (24.1)	21 (10.8)	2.63 (1.50–4.59)	0.001

Inter-pregnancy Interval <2 Years	89 (45.6)	51 (26.2)	2.36 (1.54–3.63)	<0.001
Rural Residence	124 (63.6)	108 (55.4)	1.41 (0.94–2.10)	0.098

Multivariable Analysis

Multivariable logistic regression analysis was performed to identify independent predictors of low birth weight. Maternal anemia, preeclampsia, maternal height less than 150 cm, low BMI, and short inter-pregnancy interval remained independently associated with low birth weight after adjustment for potential confounding variables.

Table 4: Independent Predictors of Low Birth Weight

Variable	Adjusted OR	95% CI	p-value
Maternal Height <150 cm	2.81	1.68–4.71	<0.001
BMI <18.5 kg/m²	2.43	1.45–4.08	0.001
Anemia	2.92	1.85–4.61	<0.001
Preeclampsia	3.37	1.76–6.45	<0.001
Bad Obstetric History	2.54	1.43–4.49	0.001
Inter-pregnancy Interval <2 Years	2.11	1.36–3.28	0.002

Summary of Findings

The present study identified several significant maternal determinants of low birth weight. Mothers with anemia, preeclampsia, short stature, low body mass index, adverse obstetric history, and inter-pregnancy intervals of less than two years were significantly more likely to deliver low birth weight infants. Among all evaluated factors, preeclampsia and maternal anemia demonstrated the strongest associations with low birth weight.

DISCUSSION

Low birth weight remains a major public health challenge, particularly in developing countries, where it contributes substantially to neonatal morbidity and mortality. The present case-control study was conducted to determine the association between maternal risk factors and low birth weight among term singleton neonates delivered at a tertiary care hospital in Quetta. The findings demonstrated that maternal height less than 150 cm, low body mass index (BMI), anemia, preeclampsia, bad obstetric history, and short inter-pregnancy interval were significantly associated with low birth weight.

In the present study, the mean maternal age was lower among cases than controls. Although mothers younger than 20 years had a higher frequency of low birth weight deliveries, the association was not statistically significant after adjustment for other maternal factors. Similar findings have been reported by Adugna and Worku (2022), who observed that maternal age alone was not an independent predictor of low birth weight when nutritional and obstetric variables were considered. However, some studies conducted in South Asia and Africa have reported a significant association between teenage pregnancy and low birth weight due to biological immaturity and poor maternal nutritional status (Demelash et al., 2015). The discrepancy may be explained by differences in study populations, socioeconomic characteristics, and healthcare utilization.

Maternal height less than 150 cm was found to be significantly associated with low birth weight in the current study. Mothers with short stature were approximately three times more likely to deliver low birth weight infants compared to taller mothers. This finding is consistent with the study conducted by Demelash et al. (2015), Maternal nutritional status, assessed through body mass index, demonstrated a significant relationship with birth weight. Mothers with BMI less than 18.5 kg/m² were more than twice as likely to deliver low birth weight infants. This finding is in

agreement with the observations of Desta et al. (2020), who reported that maternal undernutrition was a strong predictor of low birth weight. Adequate maternal nutrition is essential for placental development and fetal growth, and nutritional deficiencies during pregnancy may result in restricted intrauterine growth. The findings highlight the importance of nutritional assessment and counseling during antenatal care.

Anemia emerged as one of the strongest predictors of low birth weight in the present study. Nearly half of the mothers in the case group were anemic, and the odds of delivering a low birth weight infant were significantly higher among anemic women. Similar findings have been reported by Rahman et al. (2022), who demonstrated that maternal anemia significantly increased the risk of adverse neonatal outcomes, including low birth weight. The biological mechanism underlying this association is likely related to reduce oxygen transport capacity and impaired delivery of nutrients to the fetus. Given the high prevalence of anemia among pregnant women in Pakistan, strengthening antenatal screening and iron supplementation programs may substantially reduce the burden of low birth weight.

Preeclampsia was another significant determinant of low birth weight identified in this study. Mothers with preeclampsia had more than three times the risk of delivering low birth weight infants compared with normotensive mothers. This finding is consistent with previous research demonstrating that hypertensive disorders of pregnancy adversely affect placental blood flow and fetal growth (Magee et al., 2022). The present study also found a significant association between bad obstetric history and low birth weight. Women with a history of stillbirths, neonatal deaths, or recurrent spontaneous abortions were more likely to deliver low birth weight infants. Similar findings have been reported in previous studies, suggesting that adverse reproductive outcomes may indicate underlying maternal, genetic, or environmental factors that continue to affect subsequent pregnancies (Adugna & Worku, 2022). These women require closer antenatal surveillance and targeted interventions during pregnancy.

Inter-pregnancy interval was another important factor associated with birth weight. Mothers with intervals of less than two years between pregnancies were more than twice as likely to deliver low birth weight infants compared with those who had longer intervals. This finding supports the maternal depletion hypothesis, which suggests that insufficient time between pregnancies prevents complete restoration of maternal nutritional reserves and physiological recovery (Conde-Agudelo & Rosas-Bermúdez, 2021). Similar associations have been reported in several international studies, emphasizing the importance of family planning and birth spacing programs.

Residence was not significantly associated with low birth weight in the present study, although a higher proportion of low birth weight infants were born to mothers residing in rural areas. This finding may reflect improvements in access to maternal healthcare services and antenatal care across both urban and rural settings. Similar observations have been reported in some regional studies where socioeconomic and nutritional factors demonstrated stronger effects on birth weight than place of residence alone.

The findings of the present study have important public health implications. Most of the identified risk factors, including maternal undernutrition, anemia, preeclampsia, and short interpregnancy interval, are potentially modifiable through appropriate antenatal care interventions. Early identification of high-risk mothers, nutritional support programs, iron supplementation, blood pressure monitoring, and counseling regarding birth spacing may contribute significantly to reducing the incidence of low birth weight and improving neonatal survival.

Overall, the present study demonstrated that maternal nutritional status, anemia, preeclampsia, adverse obstetric history, and short inter-pregnancy interval are major determinants of low birth weight among term singleton neonates. These findings are consistent with existing literature and underscore the need for comprehensive maternal healthcare strategies aimed at addressing preventable risk factors during pregnancy.

STRENGTHS OF THE STUDY

The present study has several strengths. First, the case-control design enabled efficient evaluation of multiple maternal risk factors associated with low birth weight. Second, a relatively large sample size of 390 participants increased the statistical power of the study and enhanced the reliability of the findings. Third, both cases and controls were selected from the same healthcare facility, minimizing selection bias and ensuring comparability between groups. Fourth, the study assessed several important maternal characteristics simultaneously, including nutritional status, anemia, preeclampsia, obstetric history, and birth spacing, thereby providing a comprehensive understanding of maternal determinants of low birth weight. Finally, the study contributes valuable local evidence from Balochistan, where published data regarding maternal risk factors for low birth weight remain limited.

LIMITATIONS OF THE STUDY

Despite its strengths, certain limitations should be acknowledged. The study was conducted at a single tertiary care hospital, which may limit the generalizability of the findings to the wider population. Information regarding some maternal variables was partially dependent on patient recall and medical records, creating the possibility of recall bias. In addition, socioeconomic status, maternal educational level, dietary intake, and antenatal care utilization were not evaluated in detail and may have influenced birth outcomes. As an observational case-control study, causal relationships between maternal risk factors and low birth weight cannot be definitively established.

CONCLUSION

The present study identified several maternal factors significantly associated with low birth weight among term singleton neonates. Maternal height less than 150 cm, low body mass index, anemia, preeclampsia, bad obstetric history, and short inter-pregnancy interval were found to be important predictors of low birth weight. Among these factors, maternal anemia and preeclampsia demonstrated particularly strong associations with adverse birth outcomes. The findings suggest that maternal nutritional status, reproductive health, and antenatal complications play a critical role in determining neonatal birth weight.

Early identification and management of high-risk mothers through comprehensive antenatal care services may substantially reduce the incidence of low birth weight and improve neonatal survival and health outcomes.

RECOMMENDATIONS

1. Routine screening for maternal anemia should be strengthened during antenatal visits, with timely treatment and iron supplementation for affected women.
2. Maternal nutritional assessment should be incorporated into routine antenatal care, and women with low body mass index should receive nutritional counseling and support.
3. Early detection and appropriate management of preeclampsia should be prioritized to reduce adverse fetal outcomes.
4. Healthcare providers should counsel couples regarding optimal birth spacing and encourage an inter-pregnancy interval of at least two years.
5. Women with previous adverse obstetric outcomes should receive specialized antenatal monitoring and follow-up during subsequent pregnancies.
6. Community-based maternal health education programs should be implemented to increase awareness regarding modifiable risk factors associated with low birth weight.
7. Further multicenter studies involving larger and more diverse populations should be conducted to validate the findings and explore additional determinants of low birth weight in Pakistan.

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