



RISK FACTORS AND COMPLICATION ASSOCIATES WITH LOW BIRTH WEIGHT

FATORES DE RISCO E COMPLICAÇÕES ASSOCIADAS AO BAIXO PESO AO NASCER

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ABSTRACT: Aim: To evaluate maternal conditions related to low birth weight and neonatal complications. **Methodology:** Cross-sectional cohort stratifying newborns weighing less than and greater than or equal to 2,500g. **Results:** Associated maternal and fetal factors include: smoking (11.30% vs 6.8% $p=0.018$), high-risk prenatal care (38.08% vs 20.72% $p=0.00$), previous premature birth (9.34% vs 5.48% $p=0.023$), hypertensive disease during pregnancy (31.7% vs 13.16% $p=0.00$), previous hypertension (12.29% vs 4.93% $p=0.00$) and urinary tract infection (32.68% vs 24.23% $p=0.005$), neonatal ICU admission (63.39% vs 6.03% $p=0.00$) and need for mechanical ventilation (51.60% vs 7.46% $p=0.00$). **Conclusions:** Smoking, high-risk prenatal care, previous premature birth and previous pathologies were associated with low birth weight, while this condition increased the chance of adverse fetal outcomes.

KEYWORDS: Low Birth Weight. Pregnancy Complications. Prenatal Care. Risk Factors. Premature.

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RESUMO: Objetivo: Avaliar condições maternas relacionadas ao baixo peso ao nascer e complicações neonatais. **Metodologia:** Coorte transversal estratificando recém-nascido com peso menor e maior ou igual a 2.500g. **Resultados:** Entre fatores maternos e fetais associados, tem-se: tabagismo (11,30% vs 6,8% $p=0,018$), pré-natal de alto risco (38,08% vs 20,72% $p=0,00$), parto prematuro anterior (9,34% vs 5,48% $p=0,023$), doença hipertensiva na gestação (31,7% vs 13,16% $p=0,00$), hipertensão prévia (12,29% vs 4,93% $p=0,00$) e infecção do trato urinário (32,68% vs 24,23% $p=0,005$), internação em UTI neonatal (63,39% vs 6,03% $p=0,00$) e necessidade de ventilação mecânica (51,60% vs 7,46% $p=0,00$). **Conclusões:** O tabagismo, pré-natal de alto risco, parto prematuro anterior e patologias prévias associaram-se ao baixo peso ao nascer, enquanto essa condição aumentou a chance de desfechos fetais adversos.

PALAVRAS-CHAVE: Baixo Peso ao Nascer. Complicações na Gravidez. Cuidado Pré-Natal. Fatores de Risco. Prematuridade.

INTRODUCTION

Low birth weight (LBW), defined as a birth weight of less than 2,500 grams, regardless of gestational age or any specific etiology, is a significant factor influencing neonatal morbidity and mortality. The World Health Organization (WHO) established this threshold. It is estimated that annually, 14.6% of live births result in LBW, accounting for approximately 20 million of these newborns worldwide¹.

In developing countries, about 95.6% of newborns with LBW are term infants, associated with intrauterine growth restriction—characterizing a fetus that fails to reach the expected size or falls below the 10th percentile for gestational age. In contrast, in developed countries, LBW predominantly affects preterm neonates—those born before 37 weeks of gestation^{2,3}.

In Brazil, from 1996 to 2011, the prevalence of LBW was around 8%. When examining different regions of the country, researchers identified the highest rates in the more developed regions—South and Southeast—while there was a significant increase in the less developed regions—North, Northeast, and Central-West. However, despite improvements in social and maternal-infant health indicators over the past few years, the reasons behind this rise in LBW rates remain poorly understood⁴.

Several maternal risk factors are associated with LBW, including smoking, low maternal educational level, younger maternal age, marital status, insufficient weight gain during pregnancy, hypertension, genitourinary tract infections during pregnancy, parity, and fewer prenatal care visits⁵.

In addition to posing various risks for the newborn, the long-term impact of this condition is evident. LBW initially increases the risk of infections, hospitalization, cognitive and neurological dysfunctions, as well as developmental delays⁴. Furthermore, it is associated with an increased predisposition to chronic diseases later in life, such as diabetes mellitus, hypertension, and coronary artery disease².

LBW serves as a key indicator for assessing maternal and infant health. It is a complex and multifactorial event, and understanding its determinants enables targeted efforts to identify and intervene in its proximal causes. In this context, the present study aimed to assess the factors associated with and complications related to low birth weight. This understanding is essential for guiding epidemiological surveillance activities and implementing preventive interventions to enhance perinatal care.

METHODOLOGY

This is a descriptive, retrospective cross-sectional cohort study with a qualitative approach, conducted in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) initiative.

We conducted research with a sample of postpartum women attended at Darcy Vargas Maternity (MDV), in Joinville, state of Santa Catarina, which offers a multidisciplinary service for high-risk pregnant women, almost exclusively serving patients from the Unified Health System (SUS). Data collection occurred from Monday to Friday between March 1, 2022, and May 31, 2022.

The study included 1,319 women who gave birth at the maternity hospital under investigation. Participants were pregnant women over 18 years of age, after 28 weeks of gestation, who had delivered at the reference service, with newborns weighing at least 1,000 g, and whose electronic medical records were correctly filled out with all the information analyzed in the study. The exclusion criteria were twin pregnancies, congenital anomalies, and incomplete electronic medical records.

We trained the professionals participating in the project through pre-data collection meetings. Eight voluntary medical students conducted the evaluation. All researchers used a pre-established protocol to standardize the process of filling out data in a shared table.

The maternal parameters evaluated were based on outcomes and sociodemographic data such as age, marital status, race, prenatal care, risk classification, follow-up in the high-risk sector, obstetric history, associated pathologies, alcohol use, and smoking, all extracted from the maternity's medical records. Additionally, we considered fetal and obstetric aspects, including the mode of delivery, gestational age and classification, administration of corticosteroids and magnesium sulfate, and immediate neonatal outcomes. We stratified this sample into two groups according to the newborn's birth weight—those weighing 2,500 g or more and those weighing less than 2,500 g.

We analyzed the data collected using the Statistical Package for the Social Sciences (SPSS) version 21.0. Qualitative variables were presented using absolute and relative frequencies and evaluated using the Chi-Square Test. However, we used Fisher's Exact Test when there were five or fewer subjects.

We submitted the study to Plataforma Brasil 58076122.1.0000.5366, with approval from the maternity. Data collection occurred after approval from the Research Ethics Committee of the University of the Region of Joinville (Univille/Santa Catarina), according to opinion number 5.443.504 issued on June 1, 2022. We conducted the study following the parameters of Resolution 466/12 of the National Health Council.

RESULTS

Based on the established inclusion and exclusion criteria, we evaluated 1,319 postpartum women treated at the reference maternity service. The groups were divided as follows: 912 (69.15%) women with newborns weighing 2,500 g or more and 407 (30.85%) women with newborns weighing less than 2,500 g.

Among the maternal characteristics analyzed, newborns weighing less than 2,500 g were more frequently born to women identified as white or mixed race. Conversely, the group of newborns weighing 2,500 g or more showed a higher percentage of Black and Indigenous women.

In terms of prenatal care, women who received prenatal care had a lower number of low birth weight newborns compared to those who did not undergo prenatal care. On the other hand, when analyzing high-risk prenatal care, there was a significant difference, as patients who underwent this type of care were associated with a higher percentage of low birth weight newborns.

For women with a history of previous preterm births, a higher number of low birth weight newborns were observed compared to the other group. Regarding smoking, the assessment showed a significant association, with smoking being more prevalent among mothers of low birth weight newborns.

Pathologies associated with elevated blood pressure showed statistical significance, with more cases in the low birth weight group. We observed this both in pregnancy-specific hypertensive disease and in women with a prior diagnosis of chronic arterial hypertension. Lower urinary tract infections—typically screened during low-risk prenatal care, even when asymptomatic—showed a greater prevalence in the low birth weight group.

General maternal characteristics, such as maternal age, marital status, employment, alcohol use, and diagnosis of COVID-19, did not show statistical differences. Furthermore, gestational and pre-existing diabetes were not statistically significant, which we may attribute to the successful treatment of these conditions. All the data mentioned can be found in detail in Table 1.

Table 1: Maternal characteristics associated with low birth weight

| MATERNAL FACTORS ASSOCIATED WITH LOW BIRTH WEIGHT | | | |
|--|---------------------------|------------------------|----------|
| | < 2,500 (N=407) | ≥ 2,500 (N=912) | P |
| AGE UNDER 20 YEARS | 38 (9.34%) | 79 (8.66%) | 0.107* |
| AGE 20-24 YEARS | 95 (23.34%) | 254 (27.85%) | |
| AGE 25-29 YEARS | 105 (25.80%) | 267 (29.28%) | |
| AGE 30-34 YEARS | 73 (17.94%) | 168 (18.42%) | |
| AGE 35-39 YEARS | 64 (15.72%) | 97 (10.64%) | |
| AGE 40-44 YEARS | 28 (6.88%) | 42 (4.61%) | |
| AGE OVER 45 YEARS | 4 (0.98%) | 4 (0.44%) | 0.00* |
| WHITE RACE | 342 (84.03%) | 541 (59.32%) | |
| BLACK RACE | 14 (3.44%) | 48 (5.26%) | |
| MIXED RACE | 50 (12.29%) | 95 (10.42%) | |
| INDIGENOUS RACE | 1 (0.25%) | 3 (0.33%) | 0.558* |
| MARRIED | 97 (23.83%) | 171 (18.75%) | |
| SINGLE | 276 (67.81%) | 401 (43.97%) | |
| COMMON-LAW MARRIAGE | 20 (4.91%) | 35 (3.84%) | |
| DIVORCED | 14 (3.44%) | 29 (3.18%) | 0.302* |
| WITH PAID EMPLOYMENT | 151 (37.10%) | 297 (32.57%) | |
| ALCOHOL USE | 12 (2.95%) | 13 (1.43%) | 0.1* |
| SMOKING | 46 (11.30%) | 62 (6.80%) | 0.018* |
| RECEIVED PRENATAL CARE | 395 (97.05%) | 899 (98.57%) | 0.066* |
| HIGH-RISK PRENATAL CARE | 155 (38.08%) | 189 (20.72%) | 0.00* |
| PREVIOUS PREMATURE BIRTH | 38 (9.34%) | 50 (5.48%) | 0.023* |
| WITH GESTATIONAL DIABETES MELLITUS | 84 (20.64%) | 202 (22.15%) | 0.617* |
| WITH PRE-EXISTING DIABETES MELLITUS | 9 (2.21%) | 25 (2.74%) | 0.587* |
| WITH PREGNANCY-SPECIFIC HYPERTENSIVE DISEASE | 129 (31.70%) | 120 (13.16%) | 0.00* |
| WITH CHRONIC ARTERIAL HYPERTENSION | 50 (12.29%) | 45 (4.93%) | 0.00* |
| WITH COVID-19 | 18 (4.42%) | 43 (4.71%) | 0.788* |
| WITH URINARY TRACT INFECTION | 133 (32.68%) | 221 (24.23%) | 0.005* |

Source: research data.

* Pearson's Chi-Square Test.

Regarding obstetric factors, the mode of delivery differed between the groups, with the higher birth weight group having more vaginal births, while the lower birth weight group had a higher proportion of cesarean sections.

As for fetal characteristics, in terms of gestational age, a greater number of preterm and small for gestational age (SGA) newborns were observed in the low birth weight group, while full-term, post-term, appropriate for gestational age (AGA), and large for gestational age (LGA) newborns were more associated with the higher birth weight group. This explains the increased use of corticosteroids and magnesium sulfate in the group of low birth weight newborns.

In terms of outcomes, the only parameter without statistical significance was meconium aspiration. For all other parameters, newborns weighing less than 2,500 g were associated with a greater

need for neonatal intensive care unit (NICU) admission, mechanical ventilation, and respiratory disorders, including respiratory distress syndrome, hyaline membrane disease, and transient tachypnea of the newborn. These data are detailed in Table 2.

Table 2: Characteristics of maternal factors associated with complications and related to low birth weight

| COMPLICATIONS RELATED TO LOW BIRTH WEIGHT | | | |
|---|---------------------|---------------------|--------|
| | < 2,500 (N=407) | ≥ 2,500 (N=912) | P |
| VAGINAL BIRTH | 225 (55.28%) | 596 (65.35%) | 0.002* |
| CESAREAN SECTION | 182 (44.72%) | 316 (34.65%) | |
| PRETERM | 369 (90.66%) | 251 (27.52%) | 0.00* |
| FULL TERM OR POST-TERM | 38 (9.34%) | 661 (72.48%) | |
| SMALL FOR GESTATIONAL AGE | 112 (27.52%) | 34 (3.73%) | 0.00* |
| APPROPRIATE FOR GESTATIONAL AGE | 289 (71.01%) | 771 (84.54%) | |
| LARGE FOR GESTATIONAL AGE | 6 (1.47%) | 107 (11.73%) | 0.00* |
| NEONATAL INTENSIVE CARE UNIT ADMISSION | 258 (63.39%) | 55 (6.03%) | |
| REQUIRES MECHANICAL VENTILATION | 210 (51.60%) | 68 (7.46%) | 0.00* |
| RESPIRATORY DISTRESS SYNDROME | 179 (43.98%) | 45 (4.93%) | 0.00* |
| HYALINE MEMBRANE DISEASE | 55 (13.51%) | 11 (1.21%) | 0.00* |
| TRANSIENT TACHYPNEA OF THE NEWBORN | 27 (6.63%) | 8 (0.88%) | 0.00* |
| MECONIUM ASPIRATION | 0 (0.00%) | 1 (0.11%) | 0.24** |
| ANTEPARTUM CORTICOSTEROID ADMINISTRATION | 114 (28.01%) | 16 (1.75%) | 0.00* |
| ANTEPARTUM MAGNESIUM SULFATE ADMINISTRATION | 84 (20.64%) | 26 (1.85%) | 0.00* |

Source: research data.

* Pearson's Chi-Square Test; ** Fisher's Exact Test.

DISCUSSION

This study evaluated the determinants and perinatal outcomes of low birth weight (LBW) at Darcy Vargas Maternity Hospital, a tertiary facility specialized in high-risk pregnancies in southern Brazil. This allowed us to identify an increased risk of adverse pregnancy outcomes based on maternal characteristics. Regarding the adverse effects of maternal smoking, we observed a higher number of newborns with LBW—an association already described in previous studies⁶. Smoking negatively impacts pregnancy, affecting intrauterine growth and interfering with various child anthropometric measures, such as weight, length, and head circumference⁷.

Regarding maternal pathologies, we found that chronic hypertension and hypertensive disorders of pregnancy accounted for 31.70% and 12.29% of LBW cases, respectively. This result is primarily linked to uteroplacental insufficiency caused by elevated blood pressure⁸. The practical implications of these findings are significant for prenatal care management and perinatal health. Given the potential for severely compromising fetal development and the high prevalence of these conditions among pregnant women, the need for strict blood pressure monitoring is evident. This includes implementing screening protocols, regular consultations, and training professionals for targeted interventions.

A study conducted at a reference maternity hospital in Pará reported that 76.4% of pregnant women experienced some pathology during prenatal care⁴. In this context, genitourinary tract infections were the most prevalent and accounted for 35.5% of LBW cases, which is similar to our findings, where the prevalence was 32.68%.

From an obstetric perspective, we found a higher incidence of cesarean sections in LBW newborns (44.72%). This has been well documented in the literature, with similar results reported in various studies, such as one conducted through the Einstein Program in Paraisópolis, which showed a 62.7% rate of cesarean sections among LBW newborns¹⁰. The concern with cesarean sections lies in the increased maternal morbidity and mortality during the perinatal period, as well as placental complications in future pregnancies, in addition to adverse pediatric outcomes such as respiratory infections, inflammatory bowel disease, and obesity¹¹. However, cesarean sections are an obstetric procedure used to minimize maternal-fetal health risks that arise during pregnancy or labor and can be indicated early in pathologies associated with fetal presentation variations, labor dystocia, preeclampsia, and fetal distress.

Regarding prematurity, we found that women who delivered before 37 weeks of gestation were associated with LBW, low body mass index, and subcutaneous tissue, with 90.66% of patients in this group being premature—a result consistent with similar studies¹². The possibility of LBW in premature births may be related to the shorter duration of pregnancy, reducing the time for nutrient intake. In addition, placental factors such as insufficient placental function contribute to reduced blood and nutrient flow to the fetus, limiting weight gain.

A study conducted at a high-risk pregnancy reference hospital in Cuiabá, state of Mato Grosso, highlighted that 49.05% of neonatal ICU admissions were for neonatal respiratory disease, which was especially prevalent in preterm and LBW infants. This can be explained by lung immaturity and the fragility of respiratory efforts. In the mentioned study, 13.52% of pregnant women received antenatal corticosteroids, compared to 9.85% in our analysis. Properly timed corticosteroid administration is widely recommended to reduce morbidity from lung diseases and other conditions such as intraventricular hemorrhage and necrotizing enterocolitis¹³.

Therefore, LBW is an important predictor of neonatal complications. Our study found statistical significance in the increased prevalence of various pathologies compared to newborns of adequate weight, such as acute respiratory distress syndrome (43.98%), hyaline membrane disease (13.51%), and transient tachypnea of the newborn (6.63%).

Neonates requiring critical medical care are often admitted to NICUs. In our analysis, 63.39% of LBW newborns were admitted to NICUs, compared to only 6.03% of those with adequate weight. In Brazil, LBW is currently recognized as the leading risk factor for neonatal mortality, accounting for 65% of deaths occurring within the first 28 days of life^{8, 14, 15}. However, our study did not assess mortality outcomes due to the inability to monitor them after NICU admission and discharge.

Overall, our findings confirm that LBW is a significant marker of perinatal complications, associated with both maternal and neonatal conditions such as prematurity, respiratory pathologies, and NICU admission.

It is important to note that the limitations of this study are associated with its retrospective nature and the reliance on database records, which may be subject to bias due to incomplete medical records. Furthermore, the sample was limited to a single maternity hospital, potentially restricting the generalizability of the results and not allowing for follow-up of post-discharge mortality. However, given the importance and applicability of the findings, we suggest further prospective studies to complement the evaluated data.

In the area of mobile application development focused on healthcare, several methods can be used, such as Systematic Design of Instruction (SDI), Contextualized Instructional Design (CID), User-Centered Design (UCD), and the Systems Development Life Cycle (SDLC). All of these methods follow fundamental steps of analysis, design, development, implementation, and evaluation, and each of these must be well-defined and structured to ensure that the application achieves its objectives. In addition to technical development, it is essential to consider usability and the interest of the target user to ensure that the application fulfills its purpose effectively. In this context, gamification has stood out as an efficient strategy for increasing user engagement, motivation and involvement, as demonstrated in several fields, including the health field ⁷.

In an international study⁸, gamification, although it did not show a significant impact on treatment adherence in a wellness intervention, increased the cognitive and affective engagement of participants, in addition to arousing greater interest and inspiration. This type of approach is also discussed by other authors⁹, who highlight user collaboration, reward, explicit progress, goals and positive reinforcement as the main elements of gamification in health applications, all present in the application developed in this study, to promote compliance with therapeutic activities.

Despite the growth in the creation of applications for tinnitus management, most focus on masking the sound or providing temporary relief from the symptom, with few offering assessment and treatment conducted by professionals, such as speech-language pathologists and audiologists^{5,10}. This fact is corroborated by authors¹¹, who warn of the presence of applications with inadequate information available on various platforms, which underscores the importance of careful guidance by health professionals. On the other hand, a review¹⁰ on smart self-help services for the diagnosis and treatment of tinnitus concluded that many of these resources are effective, as long as there is a reliable interaction between the patient and technology. This premise was one of the bases for the development of the Zunit application, which encourages patient involvement under the supervision of the speech-language pathologist and audiologist, ensuring adequate monitoring.

National authors⁵ emphasize the need to adapt the application approach to the specific needs of each patient, allowing self-management or joint practice with the speech-language pathologist and audiologist, according to individual conditions. In the development of personalized therapeutic plans, it is essential to use assessment instruments, such as THI and VAS, which, according to previous studies¹²⁻¹⁴, present a significant correlation with regard to the assessment of tinnitus discomfort, being fast, accessible, and easy to apply.

Another important method of subjective assessment is acuphenometry, which, although it does not directly correlate with the level of reported discomfort, is essential for determining the most appropriate type of sound stimulus for treatment, in addition to allowing the measurement of therapeutic progress³. In the field of intervention, authors¹⁵ developed an application that offers sound therapy combined with Cognitive-Behavioral Therapy (CBT) for the treatment of tinnitus, demonstrating promising results. Although similar to Zunit in its ability to perform acuphenometry, the application¹⁵ differs in that it uses sound therapy exclusively for masking and includes CBT directly in the platform.

Authors¹⁶ highlight significant differences in the auditory abilities of patients with tinnitus. Studies^{17,18} on the effectiveness of AT also indicate significant results. In addition, a statistically significant reduction in the discomfort caused by tinnitus is observed in elderly hearing aid users after the application of AT, using THI as an assessment measure¹⁸.

In this sense, the development of specialized mobile applications for tinnitus treatment, such as Avazum⁵, which assists in the initial screening and assessment of tinnitus and provides guidance and referrals to patients, highlights the importance of integrating detailed assessments and collaborative

practices with health professionals. Zumit follows this same line, offering a free tool for assessment and intervention, and aims to be validated by speech-language pathologists and audiologists and tinnitus patients regarding its content, usability and therapeutic impact.

Zumit stands out from other apps on the market because of its integrated approach, which goes beyond simple sound masking. While many apps focus solely on providing temporary relief from tinnitus, Zumit offers a comprehensive assessment and intervention tool, developed under the supervision of speech-language pathologists and audiologists. The use of validated instruments, such as THI and VAS, to assess the discomfort caused by tinnitus, combined with the inclusion of an auditory training program, sets Zumit apart as a robust therapeutic tool. In addition, usability is optimized by the intuitive interface, which encourages ongoing user engagement, while the monitoring of a professional ensures that the intervention is tailored to the individual needs of each patient.

CONCLUSION

This study significantly contributes to understanding the factors influencing low birth weight, one of the main indicators of neonatal morbidity and mortality. Our research highlighted the presence of significantly associated prognostic factors for LBW, including smoking, high-risk prenatal care, previous preterm birth, and hypertensive disorders of pregnancy or pre-existing chronic hypertension. Comparison between maternal characteristics and outcomes across different groups shows that those with birth weights below 2,500 g are associated with an increased risk of adverse perinatal outcomes, such as NICU admission, mechanical ventilation, and respiratory disorders.

These findings suggest that implementing more rigorous prenatal care, including the identification and monitoring of pregnant women with risk factors, is essential for reducing the incidence of LBW. Furthermore, intensive surveillance for pregnant women with conditions such as hypertension or smoking could lead to timely interventions that improve neonatal outcomes. The complications associated with LBW underscore the importance of early interventions, which can have a lasting effect on the health and development of newborns. Finally, future research should focus on intervention strategies aimed not only at identifying risk factors but also at evaluating the effectiveness of educational and support programs for pregnant women, to mitigate the impact of low birth weight on perinatal health.

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