Adverse neonatal outcomes: a hospital-based study

Desfechos neonatais desfavoráveis: um estudo de base hospitalar

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ABSTRACT

Introduction: Unfavorable neonatal outcomes in newborns have been associated with excessive medicalization in prenatal care, delivery and birth. **Objective:** to analyze unfavorable neonatal outcomes in live births in a Brazilian municipality. **Methods:** cohort study, carried out in public and private maternity hospitals. The sample consisted of live births. The occurrence of prematurity, low birth weight, neonatal resuscitation, use of oxygen, mechanical ventilation, use of antibiotics, admission to the Intensive Care Unit and death were included as unfavorable outcomes. Explanatory models were extracted using logistic regression. **Results:** 1088 newborns were evaluated, of which 32.7% had some unfavorable neonatal outcome, the most frequent being: resuscitation maneuvers, use of oxygen and prematurity. In the unfavorable neonatal outcome model, it was a risk factor, presenting clinical intercurrence during pregnancy, and protective factors, like having a health plan and prenatal card. In the model for neonatal death, the variables that expressed a significant association were gestational age, Apgar score below 7 at the 5th minute and location of prenatal care. **Conclusion:** the high occurrence of unfavorable neonatal outcomes is a challenge to be overcome and its prevention involves actions in the process of pregnancy and childbirth.

Keywords: Newborn; Prematurity; Low weight at birth; Morbidity; Cesarean.

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RESUMO

Introdução: os desfechos neonatais desfavoráveis nos recém-nascidos têm sido associados à excessiva medicalização na atenção ao pré-natal, parto e nascimento. **Objetivos:** analisar os desfechos neonatais desfavoráveis em nascidos vivos de um município brasileiro. **Métodos:** estudo coorte, realizado em maternidades públicas e privadas. A amostra foi constituída por nascidos vivos. Foram incluídos como desfechos desfavoráveis, ocorrência de prematuridade, baixo peso ao nascer, reanimação neonatal, uso de oxigênio, ventilação mecânica, uso de antibiótico, internação em Unidade de Terapia Intensiva (UTI) e óbito. A extração dos modelos explicativos foi realizada por regressão logística. **Resultados:** avaliaram-se 1088 recém-nascidos, dos quais 32,7% apresentaram algum desfecho neonatal desfavorável, sendo os mais incidentes: manobras de reanimação, uso de oxigênio e prematuridade. No modelo do desfecho neonatal desfavorável, foi fator de risco apresentar intercorrência clínica na gestação, e fatores protetores, possuir plano de saúde e cartão de pré-natal. No modelo para óbito neonatal, as variáveis que expressaram associação significativa foram a idade gestacional, Apgar menor que 7 no 5o minuto e local das condutas de pré-natal. **Conclusão:** alta ocorrência de desfechos neonatais desfavoráveis é um desafio a ser superado e sua prevenção perpassa por ações no processo da gravidez e parto.

Keywords: Recém-nascido; Prematuridade; Baixo peso ao nascer; Morbidade; Cesárea.

INTRODUCTION

Brazil has achieved, in recent decades, important advances in public policies with positive impacts on maternal and child health. We highlight the expansion of coverage of primary care and health promotion services, the territorialization of care and the reduction of inequalities in access to basic health actions[1,2]. In this context, infant mortality has been reduced in Brazil and reached the goal established by the United Nations for the Millennium Development Goals[3].

Although the country has already prospered, in relation to child health, some indicators still persist in an unfavorable situation. Unfavorable neonatal outcomes in newborns have been associated with excessive medicalization in prenatal care, delivery and birth, represented especially by the high rates of cesarean sections in the country and also the insufficient use of effective and low-cost measures to prevent morbidity and neonatal mortality[2]. In maternity hospitals, qualified care identifies unfavorable situations for timely interventions.

Among the unfavorable neonatal outcomes, increasing prematurity, low birth weight and neonatal morbidities resulting from these situations, particularly those of a respiratory nature, stand out. These outcomes can lead to prolonged hospitalization in neonatal Intensive Care Units (ICU) and compromise the normal development of the newborn[4-6].

Given this scenario, the systematic evaluation of unfavorable neonatal outcomes is essential to improve the quality of care provided in maternity hospitals and to guarantee effective care for these mothers and their children. Thus, the objective of this study is to analyze, in addition to prematurity and low birth weight, the occurrence of other unfavorable neonatal outcomes among children. The identification of these outcomes and their determinants may provide important information for evaluating and improving the quality of care for newborns, in addition to subsidizing the proposition of preventive actions aimed at their determinants, as well as the surveillance of survivors of unfavorable situations.

METHODS

This is a hospital-based cohort study that analyzed the unfavorable neonatal outcomes of newborns, in 11 health facilities in a municipality in Minas Gerais, which had a maternity unit in operation and agreed to participate in the study. Seven of the health facilities were public and four were private. The study was carried out from November 2011 to April 2015.

The study municipality, located in the state of Minas Gerais, has an estimated population of 2,491,109 inhabitants and around 31,000 births per year. There are 5,390 health establishments, and 455 clinical and surgical obstetric beds, of which 304 belong to the SUS. There are 276 neonatal ICU beds, half of which belong to the SUS network[7].

The target population consisted of live births of puerperal women with hospital delivery, with a live birth as the outcome, regardless of weight and gestational age. Postpartum women with severe mental disorders, foreigners who did not understand Portuguese and deaf/mutes were excluded from the research.

The sample consisted of 1088 pairs of puerperal women and their fetuses, proportionally distributed in each maternity hospital in relation to the total number of births, according to the Information System on Live Births[8].

The following instruments were used for data collection: a questionnaire for interviewing postpartum women, applied at least 6 hours after delivery. This instrument consisted of identification data; sociodemographic; maternal habits and nutritional information; obstetric history; prenatal; hospital admission; labor; childbirth; newborn, postpartum and health plan. The second questionnaire was completed with data from the medical records of the puerperal woman and the newborn. It included variables on admission data, medical-obstetric history, assistance during labor and to the newborn, and conditions at hospital discharge. The variables selected for the study referred to the newborn and maternal care and characteristics capable of predicting unfavorable outcomes.

Data collection was carried out by previously trained interviewers, all nurses, and started as the institution's directors agreed to participate in the research and signed the Free and Informed Consent Form (TCLE). Collection was continuous, on all days of the week, until the sample established for each institution was completed. In each maternity hospital, eligible postpartum women and their fetuses were drawn randomly according to the number of births on that day. The puerperal woman's questionnaire was applied through a face-to-face interview, at the hospital bedside, after reading the TCLE and accepting her to participate in the research. The medical records of the puerperal woman and the newborn were consulted after the discharge of both or until the 28th day for the newborn, if he was still hospitalized.

Three outcomes were analyzed: prematurity, low birth weight and unfavorable neonatal outcome. An unfavorable neonatal outcome was defined as the occurrence of low birth weight or prematurity (main outcomes), and the presence of any of the following secondary outcomes: resuscitation maneuvers in the delivery room, use of mechanical ventilation, use of oxygen after delivery birth, Apgar less than 7 in the fifth minute, use of antibiotics, admission to the neonatal ICU and neonatal death. In addition to the specified outcomes, a neonatal mortality indicator was constructed based on the following variables: gestational age (less than 32 weeks, 32 to 36 weeks, and greater than and equal to 37 weeks); birth weight (less than 1.500 grams, 1.500 to 2.499 grams and greater than 2.500 grams); resuscitation maneuvers in the delivery room; use of mechanical ventilation; use of oxygen after birth; Apgar less than 7 at 50 minutes; use of antibiotics; hospitalization in neonatal ICU; multiple birth; phototherapy in the first 72 hours of life; surfactant use; congenital malformations; seizures; respiratory diseases (transient tachypnea, hyaline membrane disease, pulmonary hypertension, meconium aspiration syndrome); hypoglycemia and necrotizing enterocolitis.

In a first step, an exploratory analysis of the data was carried out using descriptive statistics. The incidence of major and minor neonatal outcomes and unfavorable neonatal outcome was obtained using point estimates and confidence intervals (95%) using Excel (version 15.0) and Epi-info (version 6.0).

Then, the univariate analysis of each of the three outcomes was performed: prematurity, low birth weight and unfavorable neonatal outcome, with continuous or categorical independent variables. For continuous variables, mean, median, standard deviation, *p*-value and Student's *t*-test were calculated. Categorical variables were analyzed by chi-square or Fisher's exact test when necessary. For each outcome analyzed, Odds Ratio, 95% confidence interval and p value were calculated. In the last phase of the study, multivariate analysis was performed using logistic regression. The variables tested in the regression models were selected when they presented a *p*-value ≤0.20% in the bivariate analysis. The step-by-step backward method was used in the multivariate analysis, and the likelihood ratio was used as a statistical test. Data were analyzed using the Statistical Package for Social Sciences for Windows Student Version (SPSS) software (version 18.0).

The project was approved by the Ethics Committee of the Federal University of Minas Gerais (UFMG) under opinion 0246.0.203.000-11, authorized by the directors of all participating maternity hospitals and consented by all mothers.

RESULTS

Of the total of 1088 postpartum women and their newborns who participated in the study, it was observed among the maternal variables the predominance of the age group from 20 to 34 years (72%), skin color brown/mulatto (62%), BMI< 30kg/m2 (89%), no medical history (91%), high school (54.3%), married or in a stable relationship (73%), no history of smoking (85%), paid work (53%) and belonging to economic class category C (59%). Among the variables related to prenatal care, 99% had prenatal care and received the prenatal card, and 59% had prenatal care in the public service. With regard to variables related to childbirth, 55% were vaginal, 92% had no complications, 59% had health insurance and 68% were in public hospitals.

In the evaluation of newborns, 289 (32.7%) had some unfavorable outcome. The incidence of prematurity was

slightly higher than low birth weight. Among the secondary outcomes, resuscitation maneuvers were more frequent, with 182 (19.1%) of the cases, followed by the use of oxygen after birth 131 (12.0%) and admission to the neonatal ICU 68 (7.1%). (Table 1).

Table 2 shows that mothers who had a personal history of risk (heart disease and systemic arterial hypertension, for example) had a 2.8 times greater risk of prematurity than those without a history. Those who already had a premature child and a low birth weight child in a previous pregnancy showed a risk 2.4 and 2.7 times higher for prematurity, respectively. Mothers from the state capital had a 40% lower risk of having premature babies than those from other cities in the same state. The level of education also showed a significant association: postpartum women with no education had a 3.8 times greater risk of having premature children. Mothers belonging to the lower economic class category (class D or E) also showed a risk 2.3 times higher for prematurity compared to class A or B. Those with a health plan, whether private, corporate or public agency had a 40% lower risk of having premature children. With regard to prenatal care, mothers who had their consultations at the private service or who had health insurance had a lower risk than those who only had their appointments at the public service or at both services; and those who had clinical or obstetric complications during pregnancy before hospitalization, such as placenta previa or gestational diabetes, for example, showed an almost five times greater risk for prematurity. Regarding childbirth care, the variables that were associated with prematurity were the type of delivery, whether the hospital was public or private, and complications in the current labor. If the puerperal woman had a cesarean delivery, the risk of prematurity was 1.5 times higher, if the hospital was private, the risk was 60% lower, and if the puerperal woman had some complication in the current labor, the risk was 50% for prematurity.

As shown in Table 3, the low birth weight outcome was also associated with mothers who had previously had low birth weight and premature children; risk 3.0 and 2.3 times greater, respectively, in relation to mothers who did not have children under these conditions. Regarding economic class, the risk of a child being born with low birth weight was similar between the three categories. The risk for low birth weight was higher when the mother's prenatal consultations were carried out simultaneously at both public and private services (RR=1.9) and for pregnant women who had clinical or obstetric complications during pregnancy before hospitalization (RR=3.7). There was also a higher risk of low birth weight in twin deliveries (RR=4.7) and in those performed by cesarean section (RR=1.8). The risk was 50% lower for the occurrence of low birth weight when the puerperal woman had some complication in the current labor.

There was a greater risk of newborns having an unfavorable neonatal outcome when they were children of puerperal women who had a risky personal history and who had already had a child with low birth weight (RR=1.5). Regarding socioeconomic characteristics, pregnant women who had no education, belonging to class D or E had a risk, respectively 2.2 and 1.4 times greater, of their newborns having an unfavorable neonatal outcome. For those who had health insurance, the child was protected in about 70%. It was observed that the newborns of pregnant women who received a prenatal card and who had their consultations at a private service had a lower risk for the occurrence of the event. Pregnant women who had clinical or obstetric complications during pregnancy before hospitalization had a 1.7 times greater risk for the outcome under study, and for those who had cesarean delivery, the risk was 1.3 times greater. The risk of a newborn having an unfavorable

Table 1. Distribution of main and secondary unfavorable outcomes of newborns in a hospital-based study in 11 maternity hospitals.

Outcome type	N*	Frequency	Incidence (%)	CI 95%
Unfavorable neonatal outcome	885	289	32,7	(29,8; 36,1)
Main outcomes				
Prematurity	844	88	10,4	(8,5; 12,7)
Low weight at birth	946	93	9,8	(8,0; 12,0)
Secondary outcomes				
Resuscitation maneuvers in the delivery room	952	182	19,1	(16,7; 21,8)
Use of mechanical ventilation	952	25	2,6	(1,7; 3,9)
O_2 use after birth	1088	131	12,0	(10,2; 14,2)
Apgar less than 7 in the 5th minute	951	12	1,3	(0,7; 2,3)
Antibiotic use	951	44	4,6	(3,4; 6,2)
Neonatal ICU admission	952	68	7,1	(5,6; 9,0)
Neonatal death	958	17	1,8	(1,1; 2,9)

Legend: *Total newborns in each outcome, after eliminating ignored cases. **Source:** Data obtained in the survey.

Table 2. Association between prematurity and independent variables in a hospital-based study in 11 maternity hospitals.

Variable	N	Total preterm newborns in current pregnancy	Risk of prematurity (%)	Relative Risk	Value P
Last degree attended					
University education	114	10	8,8	1,0	
High school	468	45	9,6	1,1	
Elementary School	258	32	12,4	1,4	< 0,01
None	3	1	33,3	3,8	
Have a health plan					
Yes	288	20	6,9	0,6	
No	556	68	12,2		0,02
Service where queries were carried out					
Private	248	16	6,5	1.0	
Public	548	64	11,7	1,8	< 0,001
Both	42	6	14,3	2,2	
Clinical or obstetric complications					
Yes	374	70	18,7	4,9	
No	470	18	3,8		< 0,01
Type of delivery					
Cesarean	345	45	13,0	1,5	
Normal	499	43	8,6		0,05
Intercurrence in labor					
Yes	96	5	5,2	0,5	
No	748	83	11,1		0,05
Type of hospital					
Private	211	11	5,2	0,4	
Public	633	77	12,2		0,00

neonatal outcome was 20% lower when delivery took place in private hospitals compared to public ones (Table 4).

To identify the risk factors associated with the three outcomes studied (prematurity, low birth weight and unfavorable neonatal outcome), multivariate analysis using the logistic regression technique was used. The three final models are shown in Table 5.

For the prematurity model, the number of prenatal consultations was considered a protective factor for the outcome, with a 29% lower risk of occurrence. The remaining variables were presented as a risk factor for prematurity: with the highest risk observed for clinical or obstetric complications in the current pregnancy (OR=5.53).

In the low birth weight model, the number of prenatal consultations was also a protective factor for the outcome, with a risk similar to prematurity. Twin pregnancy was a risk factor.

In the unfavorable neonatal outcome model, the fact that mothers had a pregnancy card and had health insurance were considered a protective factor for the occurrence of the event, respectively, 81% and 38% lower than mothers who did not have this situation. Clinical or obstetric intercurrence in the current pregnancy (before hospitalization) was considered a significant risk factor for the occurrence of unfavorable neonatal outcome (OR=2.32), present in the three models presented.

The model for neonatal death among newborns is shown in Table 6. The total number of neonatal deaths (zero to 28 days of life) was 17, 9 of which were classified as early neonatal deaths (zero to 7 days of life) and the variables that expressed a significant association with this event were gestational age, Apgar less than 7 in the 5th minute and location of prenatal consultations.

Table 3. Association between low weight and independent variables in a hospital-based study in 11 maternity hospitals.

Variable	N	Total low birth weight newborns during pregnancy	Underweight risk (%)	Relative Risk	Value p
Underweight child					
Yes	56	14	25,0	3,0	0,00
No	415	35	8,4		
Premature child					
Yes	52	11	21,2	2,3	0,01
No	421	38	9,0		
Service where queries were carried out					
Private	271	22	8,1	1,0	<0,01
Public	617	61	9,9	1,2	
Both	51	8	15,7	1,9	
Clinical or obstetric complications					
Yes	402	68	16,9	3,7	<0,01
No	544	25	4,6		
Type of pregnancy					
Twin (two)	9	4	44,4	4,7	<0,01
Single	937	89	9,5		
Type of delivery					
Cesarean	375	50	13,3	1,8	0,01
Normal	571	43	7,5		
Intercurrence in labor					
Yes	110	6	5,5	0,5	0,05
No	836	97	11,6		

DISCUSSION

Initially, when characterizing the mothers of newborns, a similarity was observed with another study, responsible for assessing the adequacy of prenatal care in the SUS network in the city of Rio de Janeiro, Brazil[9], in which most mothers also were between 20 and 34 years old, were brown/mulatto, lived with a partner and approximately 10% had a medical history.

Regarding prenatal care and delivery, the results of this research confirm the findings of studies that evaluated birth weight and factors associated with the prenatal period, which identified that most women have performed prenatal care, received card, with appointments at the public service and an ultrasound[10-12]. This reality indicates that access to this assistance has been guaranteed by current public policies[2]. Almost half of the children were born to primigravidae mothers (45%) and by normal delivery (55%), similar to that found in the study that evaluated the factors associated with the access of parturients to childbirth care in university hospitals[12].

The fact that most pregnant women had prenatal consultations with a medical professional, had singleton pregnancies, had no complications in the current labor and belonged to economic class C, was also similar to what was found in other studies that evaluated prenatal–natal care in Brazil[13-14]. However, the proportion of postpartum women with complete secondary education in the municipality under study was higher than the proportion in the country[15-16].

Regarding the incidence of prematurity, when compared with the rates of the last three years available from the Information System on Live Births (SINASC), it was observed that the rate of this study (10.4%) was slightly lower[17]. The prematurity rates registered at SINASC were 13.1% in the public sector and 12.2% in the private sector[18], and 12% in the study[19] that showed the rate of premature births in the United States.

It is noteworthy that the present study identified that presenting complications in the current labor was a protective factor for prematurity. This fact can be explained because in many situations the birth of a premature child occurs without the woman going into labor, therefore before any complications occur. Thus, complications during labor will possibly affect non-premature newborns. Intercurrences that predispose to prematurity are, therefore,

Table 4. Association between newborns with unfavorable neonatal outcome and independent variables in a hospital-based study in 11 maternity hospitals.

Variable	N	Total NBs with an unfavorable neonatal outcome in the current pregnancy	Risk of unfavorable neonatal outcome (%)	Relative Risk	Value p
Rich people background					
Yes	82	38	46,3	1,5	0,01
No	803	253	31,5		
Underweight child					
Yes	52	24	46,2	1,5	0,03
No	391	120	30,7		
Last degree attended					
University education	123	37	30,1	1,0	
High school	486	158	32,5	1,1	0,02
Elementary School	272	94	34,6	1,1	
None	3	2	66,7	2,2	
Economic class					
A or B	234	71	30,3	1,0	
C	534	170	31,8	1,0	0,01
D or E	117	50	42,7	1,4	
Have a health plan					
Yes	301	78	25,9	0,7	0,00
No	583	212	36,4		
I received the prenatal card					
Yes	862	276	32,0	0,5	0,02
No	12	8	66,7		
Service where queries were carried out					
Private	261	70	26,8	1.0	
Public	570	200	35,1	1.3	< 0,01
Both	46	16	34,8	1.3	
Clinical or obstetric complications					
Yes	389	168	43,2	1,7	< 0,01
No	486	123	24,8		
Type of delivery					
Cesarean	362	138	38,1	1,3	0,01
Normal	523	153	29,3		
Type of hospital					
Private	223	60	26,9	0,8	0,03
Public	662	231	34,9		

Table 5. Logistic regression model for prematurity, low birth weight and unfavorable neonatal outcome in newborns in a hospital-based study in 11 maternity hospitals.

Outcomes/Categories	Odds Ratio	IC 95%	Value *p*
Prematurity			
Number of prenatal consultations	0,71	0,59 - 0,86	0,00
Type of delivery: cesarean versus vaginal delivery	2,51	1,08 - 5,83	0,03
Previous premature child	2,80	1,02 - 7,69	0,05
Economy Class Category: C, D, or E versus A or B	3,85	1,04-14,19	0,04
Clinical or obstetric complications in the current pregnancy (before admission)	5,53	2,17 - 14,08	0,00
Low weight at birth			
Number of prenatal consultations	0,71	0,60 - 0,84	0,00
Type of delivery: cesarean versus vaginal delivery	2,46	1,13 - 5,33	0,02
Type of pregnancy: Twin versus Single	8,56	1,23 - 59,40	0,03
Previous child with low birth weight	3,50	1,43 - 8,57	0,01
Clinical or obstetric complications in the current pregnancy (before admission)	4,39	1,95 - 9,87	0,00
Unfavorable neonatal outcome			
Mother with prenatal card/maternity card	0,19	0,05 - 0,66	0,01
Mom with health insurance	0,62	0,45 - 0,86	0,00
Clinical or obstetric complications in the current pregnancy (before admission)	2,32	1,73 - 3,10	0,00

Table 6. Logistic model for neonatal death in a hospital-based study in 11 maternity hospitals.

Variable	Odds Ratio	CI 95%	Value *p*
Gestational age	0,46	0,31 - 0,69	0,00
Apgar 5'< 7	882273,41	27,13 - 190492,46	0,00
Location of most prenatal consultations: both services (public and private) versus only public or only private	173,68	4,56 - 6614,35	0,01

prior to the labor process, related to maternal characteristics and prenatal care. Among the premature newborns who may go into labor are late premature infants, which may be the result of premature labor and/or premature rupture of preterm membranes[20] and their complications during labor are due to the labor induction, in situations of risk or elective, as a non-reassuring fetal situation in identifying the fetal diagnosis[21].

For low birth weight, the rate found (9.8%) was slightly lower than those reported in the literature. SINASC shows rates of around 13.0%[16]. In another study, which evaluated low birth weight in the Northeast region of Brazil, identified that the proportion of newborns with low birth weight among adolescent mothers and young adults was 11.9% and 8.0%, respectively, approximately 82% of low birth weight newborns died[22]. According to a neonatal morbidity study, by weight range[23], the highest risk of death is for those with birth weight between 1,500 and 2,499 grams or

less than 1,500 grams. The improvement in birth weight is relevant, since it is one of the most important determinants of neonatal death[24]. More than 96% of cases of low birth weight occur in developing countries, which demonstrates that this situation is most likely to arise in unfavorable socioeconomic conditions, since under these circumstances pregnant women are more susceptible to inadequate nutrition, infections and health problems[10,24].

Considering the secondary outcomes, similar findings regarding the use of oxygen after birth are found in the study that evaluated newborns in a public hospital in Fortaleza-CE, Brazil[25], in which rates of 12.6% of newborns on mechanical ventilation and 11.03% of newborns who used a device to promote Continuous Positive Airway Pressure CPAP. Resuscitation maneuvers in the delivery room were the most frequent adverse event in this study, due to the fact that they incorporate the use of oxygen and other measures recommended to favor early adaptation and survival of

the newborn[24]. It is worth noting the association between cardiopulmonary resuscitation and intubation and neonatal death after birth[4].

In general, the incidence of unfavorable neonatal outcomes was similar to the results found by the study of the prevalence of neonatal morbidities and complications according to birth weight and gestational age in infants[5], which evaluated neonatal morbidity and complications, such as respiratory changes, use of mechanical ventilation, admission to the neonatal ICU, sepsis, weight and gestational age. It was shown that 31.4% and 27.5% of newborns had, respectively, seven to nine neonatal complications, similar to the grouping of unfavorable neonatal outcomes defined in this study. A study that evaluated prenatal care in Brazil also shows that approximately 33% of pregnant women had negative outcomes in previous pregnancies, defined as the occurrence of at least one of the following conditions: stillbirth, newborn death, premature birth, low weight, hypertension and/ or diabetes, 3 or more abortions[13]. Therefore, this situation should be included in the agenda of public policies for newborn care, especially to reduce neonatal mortality, the main component of infant mortality today. Furthermore, the follow-up of these newborns with unfavorable outcomes at birth is of great relevance to verify possible neonatal sequelae.

According to the multivariate model, the association of the number of prenatal consultations with prematurity and low birth weight demonstrates the importance of adequate prenatal care to prevent the occurrence of outcomes, and that consultations carry out the recommended procedures for each gestational age. Among the variables that explain the model for newborns with an unfavorable neonatal outcome is whether or not the mother has a prenatal card. It is worth noting that the quality of an adequate prenatal care is not only measured in the quantitative number of consultations, but also in carrying out laboratory tests, administering the tetanus vaccine, carrying out educational activities, classifying gestational risk and guaranteeing care or access to reference unit for care for high-risk pregnancies[9,11]. Thus, the pregnant woman's card or prenatal card can represent the synthesis of all this monitoring of care for pregnant women, which justifies the evidence found as a factor of protection against an unfavorable outcome in the newborn, about 81% lower.

The fact that the mother had clinical or obstetric complications, such as placenta previa and hypertensive syndromes, before pregnancy, showed a high risk for the three outcomes. This indicates the need for improvements in prenatal care, since the factors that lead to prematurity, low weight and unfavorable neonatal outcome may be due to the quality of care received during pregnancy. The study that evaluated maternal risk factors for prematurity in a public maternity hospital in the state of Manaus, Brazil[26], showed that intercurrences such as urinary tract infection and any hospitalization of the pregnant woman due to clinical-obstetric complications can trigger unfavorable outcomes for the newborn.

Cesarean delivery was a risk factor for both prematurity and low birth weight, in this study with a risk around 2.5 times greater for each outcome, in relation to this type of delivery. Evidence regarding the risk of prematurity and low birth weight in the presence of cesarean delivery is proven in studies that demonstrate the increase in morbidity and mortality among newborns, given that this mode of delivery is indicated for situations of maternal or fetal risk[2].

It is noteworthy that some of the unfavorable outcomes in newborns, such as an increase in the rate of premature birth, use of mechanical ventilation in neonates from full-term and low-risk pregnancies, and an increase in neonatal mortality, seem to be associated with cesarean deliveries. Newborns from elective cesarean sections had a higher risk of respiratory morbidity, such as tachypnea, respiratory failure syndrome, persistent pulmonary hypertension; need for oxygen for more than two days, mechanical ventilation and the use of nasal oxygen when compared to those born by vaginal delivery. The risk increases as the gestational age at birth decreases[27]. A study[28] that evaluated the occurrence of cesarean delivery associated with morbidity and mortality, evidenced adverse results such as low Apgar score, fetal distress, asphyxia, need for assisted ventilation, neonatal death related to neonatal asphyxia associated with previous cesarean section in women without health problems.

The indication for most cesarean deliveries is due to fetal impairment or premature delivery in the presence of chronic fetal distress that requires the anticipation of delivery, however, eventually this conduct is iatrogenic[29]. A study that identified the prevalence of perinatal asphyxia during the period of one year[30], showed that among all vaginal deliveries, 11.4% of newborns had an Apgar score ≤7 in the first or fifth minute, compared to 17.5% in cases of cesarean delivery.

Previous maternal antecedents in other pregnancies, like previous premature child and child with previous low weight, showed risk respectively for prematurity and for newborn with low birth weight. Studies with the evaluation of risk factors for low birth weight in public maternity hospitals and surveys on the prevention of premature births carried out in 39 countries, confirm this evidence for prematurity[18,19] and for low weight[31]. The variable economic class was associated in this analysis only with prematurity. This is evidenced in studies of maternal, obstetric and fetal risk factors associated with childbirth, which demonstrate that the less favorable economic class exhibits a greater risk of prematurity related to the greater gestational risk[32,33]. The type of pregnancy, single or twin, was associated with low birth weight, with a higher risk for twins. According to a study[31] that evaluated the risk factors for low birth weight in a Brazilian public maternity hospital, multiparity and the surgical route at birth are shown as risk factors for low birth weight.

With regard to the results found for neonatal deaths, it is worth mentioning that for the gestational age of the newborn, a study that evaluated the factors associated with birth shows an inverse relationship with neonatal death,

that is, the lower the gestational age, the greater the risk of death[34].

As for an Apgar score lower than 7 at 50 minutes, a study that brings Apgar scores and infant mortality also proves the association between the vitality index at birth and neonatal morbidity and mortality[35].

In relation to the fact that the majority of prenatal consultations carried out in the public and private service, concomitantly, are predictors of mortality, it is evidenced as a fact that, until then, had not been reported in studies on neonatal death[36]. A study that evaluated the perceptions and feelings of pregnant women about prenatal care showed that the slightest bond between pregnant women and health professionals can compromise the quality of prenatal care[37], which in a way can often occur when the prenatal care is carried out in more than one health service, considering the constant exchange of professionals who assist the pregnant woman.

However, this approach has limitations that deserve to be considered, because the population is restricted to a small sample of neonatal deaths, which can limit the model. Another possible limitation is related to the analysis of clinical and obstetric intercurrences, intervening variables, worked in a general way as intercurrences before hospitalization to give birth to the child.

Conclusion

It was found that unfavorable neonatal outcomes affected an important portion of newborns in public and private maternity hospitals. Among these outcomes, the most frequent were prematurity, low birth weight (main outcomes), resuscitation maneuvers in the delivery room, use of oxygen after birth, and admission to the NICU (secondary outcomes).

The determinants for the occurrence of unfavorable outcomes were maternal and care conditions. Among the maternal factors, the presence of intercurrences in the current pregnancy and socioeconomic issues, economic class C, D or E stood out. The care determinants were related to prenatal care and type of delivery.

Evaluating unfavorable neonatal outcomes in newborns allowed a better understanding of the prenatal, delivery and birth process, elucidating still persistent problems and challenges to be overcome on the agenda in maternal and child health. Actions in this regard should start early, acting in situations that are still at risk during prenatal care and that permeate the entire process of pregnancy and childbirth, i.e., actions that meet women's health needs and social vulnerability.

Authors' collaboration

We describe contributions to the papers using the taxanomy (CRediT) provide above: Conceptualization, Investigation, Methodology, Visualization & Writing – review & editing: Juliana Cristina Pereira; Eunice Francisca Martins and Edna Maria Rezende. Project administration, Supervision & Writing – original draft: Juliana Cristina Pereira; Kleyde Ventura de Souza; CCC; Assis do Carmo Pereira Júnior. Validation & Software: Bráulio Roberto Gonçalves Marinho Couto. Data curation & Formal Analysis: Juliana Cristina Pereira; Kleyde Ventura de Souza; Assis do Carmo Pereira Júnior and Eunice Francisca Martins.

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