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MATERNAL AND CHILD RISK FACTORS ASSOCIATED WITH NEONATAL MORTALITY

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ABSTRACT: This was a cross-sectional study that investigated maternal and child factors associated with neonatal mortality. Data was obtained from the Live Births and Mortality Information Systems integrated by linkage. A total of 9,349 live births and 78 deaths in the neonatal period, which occurred in 2010 in Cuiabá-MT were analyzed. Univariate and multivariate analyzes were performed. In the multiple logistic regression, neonatal mortality was associated with: maternal age less than 20 years; prematurity; low birth weight; Apgar score less than seven at 1 and 5 minutes; and presence of congenital anomaly. The results highlight the need to improve the quality of prenatal care in order to prevent low birth weight and prematurity. The association between neonatal death and low Apgar score at 1 and 5 minutes indicates the importance of investments in delivery care.

DESCRIPTORS: Infant mortality. Risk factors. Information systems. Pediatric nursing. Maternal-child nursing.

FATORES DE RISCO MATERNOS E INFANTIS ASSOCIADOS À MORTALIDADE NEONATAL

RESUMO: Estudo transversal que investigou os fatores maternos e infantis associados à mortalidade neonatal, com dados obtidos dos Sistemas de Informação sobre Nascidos Vivos e Mortalidade, integrados por *linkage*. Analisaram-se 9.349 nascidos vivos em Cuiabá-MT, no ano de 2010, sendo 78 que foram a óbito no período neonatal. Realizaram-se análises univariada e múltipla. Na regressão logística múltipla, mantiveram-se associados à mortalidade neonatal: idade materna menor que 20 anos; prematuridade; baixo peso ao nascer; Apgar menor que sete nos 1º e 5º minutos; e presença de anomalia congênita. Os resultados apontaram a necessidade de melhoria na qualidade da atenção pré-natal para a prevenção de baixo peso e prematuridade. A associação entre óbito neonatal e baixo Apgar nos 1º e 5º minutos indica a importância de investimentos na assistência ao parto.

DESCRITORES: Mortalidade neonatal. Fatores de risco. Sistemas de informação. Enfermagem pediátrica. Enfermagem materno-infantil.

FACTORES DE RIESGO MATERNO-INFANTILES ASOCIADOS A LA MORTALIDAD NEONATAL

RESUMEN: En este trabajo se estudiaron los factores materno-infantiles relacionados con la mortalidad neonatal, a partir de datos obtenidos de los Sistemas de Información de Nacidos Vivos y Mortalidad integrados por vinculación. Se analizaron 9.349 nacidos vivos en Cuiabá-MT, en 2010, 78 de los cuales murieron en el período neonatal. Se realizó análisis univariado y multivariado empleando la regresión logística. En el modelo múltiple, se mantuvo asociada con la mortalidad neonatal: la edad materna menor de 20 años; la prematuridad; bajo peso al nacer; Apgar menor a siete en el 1 y 5 minutos; y la presencia de anomalías congénitas. Los resultados indicaron la necesidad de mejorar la calidad de la atención prenatal, para la prevención del bajo peso al nacer y la prematuridad. La asociación entre la muerte neonatal y baja puntuación de Apgar en el 1 y 5 minutos indica, a su vez, la importancia de la atención del parto.

DESCRIPTORES: Mortalidad infantil. Factores de riesgo. Sistemas de información. Enfermería pediátrica. Enfermería materno-infantil.

INTRODUCTION

The infant mortality rate is an important indicator of the health of a population.[1] In general, it reflects the living and socioeconomic development conditions, the access to health services, the quality of the services and the maternal and child healthcare resources available.[2]

In Brazil, the infant mortality rate has shown a significant reduction in recent decades, with a decline from 47/1,000 live births in 1990 to 14.6/1,000 live births in 2012.[3] Despite this progress, the reduction of infant mortality still represents a challenge for health services, especially considering that, since the 1990s, neonatal mortality has configured the main cause of infant mortality in the country, without presenting a reduction.[1] In 2013, there were 8.4 deaths/1,000 live births, a much higher index than that found in countries such as Chile (4.9/1,000 live births), Canada (3.4/1,000 live births), Japan (1/1,000 live births) and Iceland with 0.9/1,000 live births.[4]

Neonatal mortality in Brazil represents more than 70% of the mortality in the first year of life, with 25% of deaths occurring in the first 24 hours postpartum.[3] This situation is the result of a combination of several factors, which are closely linked to the maternal and newborn health conditions, the living conditions of the woman and the family and, especially, to the quality of care provided to the mother during pregnancy, delivery and postpartum and to the newborn in the first moments of life and during hospitalization.[5-7]

Thus, prenatal and hospital care provided to women and newborns are the main determinants of neonatal mortality in relation to the health services. However, some biological and social maternal characteristics have traditionally been associated with neonatal deaths, such as maternal age, marital status, income, education, parity and diseases during pregnancy.[8-10] An increase in neonatal mortality risk is also associated with newborn characteristics, such as birth weight, gestational age and Apgar, among others.[5,10-11]

In the city of Cuiaba, capital of Mato Grosso (MT) state, neonatal mortality has been little studied, despite the high rates of neonatal deaths - 8.7/1,000 live births in 2007 and 8.2/1,000 live births in 2010.[12-13] This study is therefore justified as it aimed to investigate the maternal and child risk factors, present in the Live Birth and Death Declaration, which were associated with neonatal mortality in Cuiabá-MT.

Considering that the analysis of risk factors for neonatal mortality gives visibility to the issues and provides subsidies for decision making in the implementation of improvement actions for the health services, the results can help health managers in the planning and implementation of resources in priority areas for reducing mortality in the neonatal period.

METHOD

This cross-sectional study examined 9,349 births in the period from 1st January to 31st December /2010 and 81 neonatal deaths, i.e., within the first 27 days of life, which occurred from 1st January 2010 to 27th January 2011. The data from this period represented the most recent information available at the time of the study.

The data sources were the Live Births Information System (SINASC) and the Mortality Information System (SIM) of mothers living in Cuiabá-MT at the time of childbirth. The SINASC, established in 1990, makes it possible to obtain data on pregnancy, delivery and birth conditions. The system is based on the information from the Live Birth Declaration (DN). It is a standardized document used throughout the country, the emission of which is mandatory for health institutions where deliveries are performed. The SIM provides data regarding mortality epidemiology throughout the country and is based on the Death Declaration (DO), which includes information on identity and causes of death, as well as the DN number for deaths of children less than one year of age.

Data from both systems were provided by the Municipal Health Department of Cuiabá-MT, with identification data that enabled the linkage of the databases. The DN number was used as the variable of linkage for the databases, as it is unique and exclusive for each live birth and appears on the DO. A deterministic search was performed, that is, for the exact linkage of the DN numbers within the two databases, as well as the comparison of the names of the mothers and children in cases of divergence - for example: when the DN number in the SIM was not found in the SINASC.

The final database of the study resulted from the linkage of the SINASC and SIM data, as it was necessary to identify, among the live births, those who died in the neonatal period. Of the 81 neonatal deaths identified in the SIM, 78 (96.2%) were identified in the SINASC.

Considering that some of the SINASC variables presented a high percentage of blank/ignored

information (degree of incompleteness), the exposure variables analyzed were: a) for the mother: age (<20 or ≥20 years), education (elementary, high school and higher), number of living children (<2 or ≥2), dead children (yes or no), number of prenatal consultations (£6 or >6) and type of delivery (vaginal or cesarean); and b) for the newborn: gender (male or female), Apgar score at 1 and 5 minutes (<7 or ≥7), gestational age (<37 weeks or ≥37 weeks), presence of congenital anomalies (yes or no) and race/color (white or nonwhite).

It should be noted that in 2010, a new DN model was deployed in the country; in Cuiabá, this innovation took place from September. Thus, due to the presence of two DN models in the study year (2010), some variables, such as maternal occupation and month prenatal care commenced, available in one or other model, presented a high percentage of unknown/unrecorded information and were excluded from the analysis.

Data were analyzed using the Statistical Package for the Social Sciences (SPSS version 18) software. The dependent variable was neonatal death and the independent variables were characteristics of the mother and newborn present in the DN and DO. Variables with p<0.20 in the univariate analysis were included in the multiple logistic regression model, with 5% significance level. The strength of associations between the dependent and the independent variables were evaluated through the odds ratio (OR), both in the univariate analysis (crude OR), and multivariate analysis (adjusted OR). The Hosmer & Lemeshow test (H&L) was used to check the validity of the logistic regression model, in that, if the p-value was greater than 0.05, the model could be considered adequate.

The development of the study met national and international ethical standards for research involving human subjects and was approved by the Research Ethics Committee of the Júlio Muller University Hospital of the *Universidade Federal do Mato Grosso*, under authorization No. 968/CEP-HUJM/2010.

RESULTS

Table 1 presents the descriptive analysis of the maternal variables. A statistically significant difference was observed between the age of mothers of newborn survivors and of those that died in the neonatal period, as well as in the number of prenatal appointments, highlighting the high proportion of mothers with six consultations or less among newborns that died (68.4%).

Table 1 - Descriptive analysis of the variables related to mothers of newborn survivors and those who died in the neonatal period. Cuiabá-MT, 2010

Variables	Survivors n=9,349 n(%)	Deaths n=78 n(%)	Univariate p-value	Crude OR	95% CI
Maternal age			0.036		
<20	1,665 (17.8)	21 (26.9)		1.71	1.03-2.83
≥20	7,684 (82.2)	57 (73.1)		1.00	
Maternal education			0.708		
0 to 7 years	1,621 (17.3)	16 (20.5)		1.34	0.67-2.68
8 to 11 years	5,568 (59.6)	46 (59.0)		1.12	0.63-1.98
12 or more	2,160 (23.1)	16 (20.5)		1.00	
No. of children born alive*			0.887		
<2	6,443 (75.5)	50 (74.6)		1.00	
≥2	2,095 (24.5)	17 (25.4)		1.05	0.60-1.81
Stillborn children*			0.999		
No	6,637 (82.8)	54 (83.1)		1.00	
Yes	1,379 (17.2)	11 (16.9)		0.98	0.51-1.89
No. of prenatal consultations*			<0.001		
£6	3,038 (32.8)	52 (68.4)		4.51	2.77-7.33
>6	6,238 (67.2)	24 (31.6)		1.00	
Delivery type			0.246		
Vaginal	3,702 (39.6)	36 (46.2)		1.00	
Cesarean	5,647 (60.4)	42 (53.8)		0.76	0.49-1.19

*There was loss of information.

Regarding the newborns, there was a higher proportion of males among the deaths (60.3%), although this difference was not statistically significant. However, gestational age less than 37 weeks (prematurity), low birth weight, Apgar score less than seven at 1 and 5 minutes and presence of anomalies were statistically higher among the neonates that died (Table 2).

Table 2 - Descriptive analysis of the variables related to newborn survivors and those who died in the neonatal period. Cuiabá-MT, 2010

Variables	Survivors n=9,349	Deaths n=78	Univariate		95% CI
	n(%)	n(%)	p-value	Crude OR	
Gender			0.112		
Male	4,782 (51.2)	47 (60.3)		1.45	0.92-2.29
Female	4,567 (48.8)	31 (39.7)		1.00	
Gestational age at birth*			<0.001		
<37	801 (8.6)	51 (65.4)		21.42	13.35-34.35
≥37	8,531 (91.4)	27 (34.6)		1.00	
Low birth weight			<0.001		
Yes	771 (8.2)	54 (69.2)		26.84	16.49-43.68
No	8,578 (91.8)	24 (30.8)		1.00	
Apgar 1 minute*			<0.001		
<7	453 (4.8)	47 (61.8)		35.33	22.01-56.72
≥7	8,880 (95.2)	29 (38.2)		1.00	
Apgar 5 minutes*			<0.001		
<7	115 (1.2)	30 (39.0)		68.87	41.55-114.16
≥7	9,218 (98.8)	47 (61.0)		1.00	
Congenital anomaly *			<0.001		
Yes	60 (0.6)	9 (11.5)		23.57	11.17-49.76
No	9,285 (99.4)	69 (88.5)		1.00	

* There was a loss of information.

In the univariate analysis (Tables 1 and 2) the following maternal and child factors were associated with mortality in the neonatal period: age less than 20 years (OR=1.71; 95%CI:1.03-2.83); number of prenatal consultations equal to or less than six (OR=4.51; 95%CI:2.77-7.33); gestational age at birth less than 37 weeks (OR=21.42; 95%CI:13.35-34.35); low birth weight (OR=26.84; 95%CI:16.49-43.68); Apgar score less than seven at 1 minute (OR=35.33; 95%CI:22.1-56.72) and at 5 minutes (OR=68.87; 95%CI:41.55-114.16); and presence of congenital anomalies (OR=23.57; 95%CI:11.17-49.76).

Table 3 shows the results of the multiple logistic regression analysis, in which maternal age (p=0.046), gestational age (p=0.004), birth weight (p<0.001), Apgar at 1 and 5 minutes (p<0.001) and congenital anomaly (p<0.001) were maintained in the final model. Newborns of adolescent mothers presented a greater chance of death (OR=1.85; 95%CI:1.01-3.38) compared to mothers over 20 years of age. The chance of children with low birth weight dying in the neonatal period was 5.50 times greater compared to those born with normal weight. Premature children (born at gestational age less than 37 weeks) were more likely to die in the neonatal period (OR=3.16; 95%CI:1.43-6.95), as were newborns with an Apgar score lower than seven at 1 (OR=7.17) or 5 (OR=7.70) minutes. Children with congenital anomalies showed a higher chance of death in the neonatal period (OR=17.78; 95%CI:6.68-47.27). The Hosmer & Lemeshow test showed the adequacy of the final model (p=0.425).

Table 3 - Multiple logistic regression of the maternal and newborn variables that were associated with neonatal death. Cuiabá-MT, 2010

Variables	Multiple Adjusted OR	95% CI	p-value*
Maternal age			
<20	1.85	1.01-3.38	0.046
≥20	1.00		
Gestational age at birth (weeks)			
<37	3.16	1.43-6.95	0.004
≥37	1.00		
Low birth weight (< 2,500g)			
Yes	6.50	3.00-14.05	<0.001
No	1.00		
Apgar 1 minute			
<7	7.17	3.78-13.60	<0.001
≥7	1.00		
Apgar 5 minutes			
<7	7.70	3.67-16.15	<0.001
≥7	1.00		
Presence of congenital anomaly/malformation			
Yes	17.78	6.68-47.27	<0.001
No	1.00		

*Hosmer & Lemeshow test: p=0.425.

DISCUSSION

As demonstrated in other Brazilian cities,[5,14-15] low birth weight, prematurity, low Apgar scores at 1 and 5 minutes and the presence of congenital abnormalities were risk factors associated with mortality in the neonatal period in Cuiabá-MT.

Although biological factors present greater final power in determining neonatal death, the social determinants of these events cannot be ignored. However, indicators, such as family income, were not available in the information systems on live births and mortality used in this study, while the data on maternal occupation presented a high degree of incompleteness, which prevented their use - which can be considered a limitation of this study.

Of the sociodemographic variables (age, marital status and maternal education), only being an adolescent mother (under 20 years of age) was associated with neonatal death in the city of Cuiaba-MT. Maternal age is an important risk factor for infant and neonatal mortality and fetal loss, with the greatest risk focused in the extreme age groups, that is, among the very young and those with very advanced age.[14-16] A study that evaluated neonatal deaths in the period 2001 to 2005, in the city of Serra-ES, revealed a significant association between maternal age and neonatal death, with a three times higher risk of death among younger (<15 years) and older mothers (35 years or more).[17]

With regard to the pregnancy characteristics, the absence of, or inadequate, prenatal care has been highlighted as an important risk factor associated with neonatal death.[5-6] In the present study, the univariate analysis showed that infants born to mothers with less than seven prenatal consultations were more likely to suffer neonatal death (OR=4.51) than those born to mothers with seven or more consultations. These findings are consistent with the results found in a study conducted in the city of Serra-ES, which found that the greater the number of consultations during pregnancy, the less chance of neonatal death.[17]

In turn, a cross-sectional study, which identified the neonatal mortality predictors in the poorest regions of Shaanxi Province, China, showed that the odds of neonatal death were significantly higher for women who did not receive prenatal care in the first trimester of the pregnancy (OR=2.49), which reinforces the importance of prenatal care from early pregnancy to control neonatal mortality.[8]

According to the guidelines of the Ministry of Health of Brazil, it is recommended that at least six consultations are performed during the pregnancy, with preferably one in the first trimester, two in the second and three consultation realized in the third trimester of the pregnancy.[19] In addition to the number of consultations performed, other aspects are relevant for the reduction of neonatal deaths, among them, the early initiation of prenatal care in the first trimester; performance of routine examinations; detection and treatment of maternal diseases; and provision of information on the effects of alcohol consumption, smoking and other care provided to the mother.[20-21]

Thus, the relationship between neonatal mortality and prenatal care is not restricted to the number of consultations. It depends of the quality of the care,[22] as adequate prenatal monitoring permits the early identification and prevention of harmful occurrences for the fetus/newborn and pregnant woman.[23] Therefore, from the perspective of the qualification of prenatal care to reduce neonatal deaths, it is not only necessary for pregnant women to have access to services and routine examinations, but also that the professionals use all clinical knowledge to direct interventions in adverse situations.[21]

The Apgar score reflects the vitality conditions of the newborn and is directly related to the quality of the delivery care. The score at 1 minute of life expresses the conditions of the pregnancy and the birth, while the index at 5 minutes reflects the care provided during the birth and postpartum, and the influence of factors that act even before birth. A study carried out in eight public hospitals found that an Apgar between zero and six at 5 minutes was strongly associated with early neonatal death.[24] This is a parameter that can predict neonatal death in Brazil[12,14,25] and also in the USA.[26] Thus, the lower the Apgar score at 1 and 5 minutes of life, the lower the chances of child survival, which highlights the importance of the quality of care provided during labor, as well as the immediate care to the newborn after birth.

In this study, an Apgar score lower than seven at 1 and 5 minutes remained associated (OR=7.17 and 7.70, respectively) with neonatal death in the adjusted logistic regression, reiterating the results of other investigations.[10,14,17] It is important to note that, although an Apgar score below seven is considered a predictor of increased risk of neonatal death, a study performed in Rio Grande do Sul state found that scores lower than eight also indicate greater vulnerability for newborns.[14] Therefore, the need for investments in delivery care is evident, with reorganization of obstetric and neonatal care that effectively contribute to reducing the incidence of low Apgar scores and, consequently, reducing perinatal hypoxia and neonatal death.[25]

Among the variables analyzed, low birth weight and preterm birth were considered the most relevant.[1,16,27] Low weight was strongly associated with neonatal death (OR=6.50), as has been observed in other studies.[5,14-15] A cohort study of low birth weight live births (between 500g and 2,499g) showed that newborns weighing less than 1,500g had a much greater chance of neonatal death (OR=38.73) compared to those born weighing between 1,500 and 1,999g (OR=3.94).[23] There is therefore evidence that the lower the birth weight the higher the risk of death.[14]

Studies conducted in other countries also confirm low birth weight as one of the most relevant risk factors for neonatal mortality. A cohort study performed in Japan with children of very low birth weight, between 2003 and 2008, found a higher mortality rate among children with birth weight between 501 and 750g (25.6 to 17.7%).[28] In Valdivia, Chile, a descriptive study of secondary data from the national registries of vitality and mortality, for the 2000-2005 period, showed that the probability of mortality in newborns under 1,500g increased by between 88% and 200%.[27]

As with birth weight, gestational age at birth was also associated with neonatal mortality, with three times greater likelihood (OR=3.16) among premature infants (infants with gestational age less than 37 weeks). A cohort study which examined the determinants of neonatal mortality in Rio Grande do Sul state showed that preterm infants had double the chance of dying compared to full term infants.[4] In another cohort study, it was found that premature infants born at 31 weeks or less of gestation presented a greater chance of neonatal death (OR=96.94). [25]

The causes of low birth weight can include prematurity and intrauterine growth restriction (IUGR), indicators that reflect the quality of care provided to the mother during pregnancy. Thus, these variables should not be viewed in isolation, as they are mediators of social determinants, such as socioeconomic characteristics and maternal education level, and biological characteristics, such as lifestyle and maternal morbidity, while also reflecting access to health services and the quality of care provided during pregnancy.[29]

Another important risk factor for neonatal death was the presence of congenital anomalies

(OR=17.78), which confirms the results of other Brazilian studies.[14,25,30] In Brazil, congenital anomalies represent the second most frequent underlying cause of neonatal death, following the conditions originating in the perinatal period. Deaths from congenital malformations are difficult to reduce, as the majority have an unpreventable cause and unknown etiology,[30] although the malformations related to neural tube closure defects can be prevented by supplementation with folic acid in the preconception period, which depends on the guidance of health professionals.

It should be noted that there was no statistically significant association between neonatal death and maternal education (p=0.708), the only variable related to the maternal sociodemographic profile analyzed. The social determinants should be considered in future studies monitoring neonatal mortality, as the sociodemographic and living conditions, which can be analyzed based on variables such as marital status, income, education and maternal occupation, more linked to structural processes of society, constitute the causal network for the determination of neonatal mortality. Thus, future studies should evaluate other determinants and perform other types of analysis, such as the spatial distribution of deaths according to the place of maternal residence, which could certainly contribute to the identification of priority areas for intervention.

Analysis of secondary data, such as that of the present study, which used SINASC and SIM information, can provide subsidies for the planning, management and evaluation of health practices. However, care should be taken in the interpretation of the results, because the findings may be affected by the coverage and quality of the information. Despite this limitation, the results reiterated the risk factors described in the literature, such as: low birth weight, prematurity, lower Apgar at 1 and 5 minutes, presence of congenital anomalies and maternal age less than 20 years, which were associated with mortality in the neonatal period, providing a baseline for planning of local prevention actions, as well as policies in the area of maternal and child health.

It is important to note that the technique of linkage between the databases of live births and deaths showed ample feasibility for use in service studies, as it allows the consistency of the official databases to be evaluated and health indicators to be obtained. This fact can assist managers and nurses of the public network for in the monitoring, evaluation and planning of actions at the municipal level.

CONCLUSIONS

Maternal age less than 20 years, low birth weight and prematurity were associated with neonatal mortality. These results suggest the need for improvements in prenatal care quality in the city, an action that will certainly be reflected in the reduction of neonatal mortality. In turn, the association between low Apgar at 1 and 5 minutes and neonatal mortality indicates the importance of investments in delivery care.

Our results suggest that the risk factors associated with neonatal deaths in Cuiabá are related to the quality of care provided to the mother and child. With regard to sociodemographic determinants, further studies should be developed, with the inclusion of other variables that show their influence on neonatal deaths.

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