Determining factors for neonatal mortality in a city in the Southern Region of Brazil

ORIGINAL ARTICLE

FATORES DETERMINANTES DA MORTALIDADE NEONATAL EM UM MUNICÍPIO DA REGIÃO SUL DO BRASIL

FACTORES DETERMINANTES DE LA MORTALIDAD NEONATAL EN UN MUNICIPIO DE LA REGIÓN SUR DE BRASIL

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ABSTRACT

This is an ecological quantitative study to identify risk factors that determined neonatal death between the years of 2000 to 2009 in Londrina, Paraná, using data from Birth Certificates, Death Certificates and Infant Death Investigation Forms. The variables maternal age, years of education, family income, occupation, marital status, type of delivery, and number of prenatal appointments were not associated to neonatal death. To the contrary, birth weight, gestational age, Apgar score at 1 and 5 minutes, and place of birth were identified as statistically significant variables. More than 73.0% of newborns died within early neonatal period. The predominant basic cause of death was perinatal problems (77.7%), 72.6% of which were preventable, and the majority of which could be reduced with adequate control over pregnancy/birth. These results highlight the need for investments in prevention of premature delivery by improvement of health care in prenatal and birth periods, in an equanimous, accessible and comprehensive manner in all levels of maternal and child health care.

DESCRIPTORS
Infant mortality
Risk factors
Cause of death
Neonatal nursing
Ecological studies

RESUMO

Pesquisa quantitativa do tipo ecológico cujo objetivo foi identificar os fatores de risco que determinaram o óbito neonatal no município de Londrina, Paraná, entre 2000 e 2009. Verificou-se que idade materna, escolaridade, renda familiar, ocupação, situação conjugal, tipo de parto e número de consultas pré-natais não se associaram ao óbito neonatal. Entretanto, o peso ao nascer, a idade gestacional, o índice de Apgar no 1º e 5º minutos e local do parto mostraram-se estatisticamente significativos. Mais de 73,0% dos recém-nascidos evoluíram para óbito no período neonatal precoce. A causa básica predominante foi a afecção perinatal (77,7%), sendo que 72,6% das mortes foram consideradas evitáveis e a maioria, reduzível por controle adequado da gravidez e do parto. Tais resultados reforçam a necessidade de investimentos na prevenção do parto prematuro com assistência antenatal e ao parto equitativa, acessível e integral entre os diferentes níveis de atenção à saúde materno-infantil.

DESCRITORES
Mortalidade infantil
Fatores de risco
Causas de morte
Enfermagem neonatal
Estudos ecológicos

RESUMEN

Investigación cuantitativa de tipo ecológico objetivando identificar los factores de riesgo que determinaron el deceso neonatal en el municipio de Londrina-Paraná entre 2000 y 2009. Se verificó que la edad materna, escolaridad, renta familiar, ocupación, situación conyugal, tipo de parto y número de consultas prenatales no se asocian al fallecimiento. Mientras tanto, el peso al nacer, la edad gestacional, el índice de Apgar en los minutos 1 y 5 y el lugar del parto sí mostraron significatividad estadística. Más del 73,0% de los recién nacidos fallecieron en el período neonatal precoz. La causa predominante fue afección perinatal (77,7%), considerándose que 72,6% de las muertes fueron evitables, y la mayoría, reducible por control adecuado del embarazo y parto. Tales resultados refuerzan la necesidad de inversiones en prevención del parto prematuro con atención prenatal y al parto equitativo, accesible e integral entre los diferentes niveles de atención de la salud materno-infantil.

DESCRIPTORES
Mortalidad infantil
Factores de riesgo
Causas de muerte
Enfermería neonatal
Estudios ecológicos

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INTRODUCTION

Neonatal mortality has become more evident since the 1990s in many developing countries, due to the reduction of deaths in the post-neonatal period. Neonatal deaths correspond to 65% of all childhood deaths under one year of age. This evidence also refers to improved notification in the ministerial databases[1-4].

The global estimate is that four million newborns die each year, 250 every hour, the majority of which are due to preventable causes. Among the primary causes of neonatal deaths are: premature birth (28%), severe infections (26%), and perinatal asphyxia (23%). Low birth weight continues to be an important indirect cause[5]. In 2004, estimates of neonatal mortality reduction in developed countries identified the smallest TMN in Japan (3/1000 LB) followed by Germany (4 to 6/1000 LB), the Nordic European countries (5/1000 LB), and the United States (6 and 7/1000 LB). In contrast, African countries had the highest rates with 40 to 60/1000 LB. In Latin America, it was 13 to 15/1000 LB, and specifically in Brazil, it was 15/1000 LB[2].

In Brazil, in the same period, the number of live births in the country was 3,026,548 and the early (up to seven days of life) and late (seven to 28 days) neonatal mortality coefficients were, respectively: 11.49/1000 LB and 3.51/1000 LB[4]. These rates maintained the country with a value five times higher than that of Japan, which exhibits the lowest indexes of neonatal deaths in the world.

In 2007, despite a reduction of births in the country to 2,891,328, compared with the year 2004 (3,026,548), neonatal mortality remained high, representing 68% (13.61/1000 LB) of all deaths in those under one year of age: 10.35 deaths/1000 LB of the early neonatal and 3.26/1000 LB of the late neonatal component[4]. Between 2004 and 2007, the Brazilian states also showed a decrease in birth with the exception of the northern region, which increased from 309,136 to 311,813 births. Neonatal mortality in the northeastern region had the highest coefficients in the country, although it decreased from 21.16/1000 LB to 19.77/1000 LB, followed by the northern region (15.63/1000 LB to 14.55/1000 LB) and the midwestern region (from 12.39/1000 LB to 11.14/1000 LB)[4].

The southern region presented the lowest mortality rates of this component, decreasing from 10.0/1000 LB in 2004 to 8.7/1000 LB, in 2007, followed by the southeastern region which dropped from 11.21 to 9.95/1000 LB. Both regions also reduced the number of births in the same period[3,4].

Although in some Brazilian states neonatal mortality rates are in the process of reduction and/or stagnation, nevertheless, several studies have shown that the majority of these deaths are strongly linked to socioeconomic disparties and access to health services, in addition to biological conditions, such as: birth weight, Apgar score and gestational age[1,7-12].

Given the context of neonatal mortality throughout the decades, this study had as its objective to identify factors that led to neonatal death, in Londrina, Paraná.

METHOD

This was a quantitative, temporal ecological study which analyzed all neonatal deaths that occurred between 1 January 2000 to 31 December 2009. Data were collected from the Live Birth Declaration (DN), Declaration of Death (DO) and Infant Death Investigation Sheets of the Municipal Committee for the Prevention of Maternal and Child Mortality (CMPMMI).

The inclusion criteria for the study were: all children who were born alive and that subsequently died in the neonatal period (0-27 days); all neonatal deaths analyzed by CMPMMI; and having been a resident in urban or rural areas of the city of Londrina-PR.

The variables studied to identify factors that led to neonatal death were: maternal characteristics (age range; education; household income; occupation; marital status; and number of prenatal consults), type of delivery, gestational age, birth weight, Apgar scores at one and five minutes, place of birth, basic cause of death, and classification of preventability.

The city in question is located in the northern region of Paraná, with a population of 511,000 inhabitants, and it is composed of a health care system that provides care through 54 basic health units in rural and urban areas, a mobile urgent and emergency service, laboratories, and walk-in outpatient care.

In the ten years studied, 793 children under one year of age, residing in the city, died. Of these, 783 were investigated by CMPMMI, including 537 neonatal deaths (68.6%), the populaton of this study. Data collection occurred from March to July of 2010. Data were scanned into the computer program *Epi Info*® 2002. The *Statistical Package for the Social Sciences*® was used for univariate and bivariate analysis, applying the Chi-square and Fisher exact tests, with the final descriptive value of $p < 0.05$.

The research project was approved under process nº CAAE 0044.0.196.000-09/843/2009/CEP-EEUSP, by the Committee on Ethics in Research in the School of Nursing of the *Universidade de São Paulo*; it was also authorized by the Board of Health Care of the Municipal Health Authority (*Diretoria de Atenção à Saúde da Autarquia Municipal de Saúde*).

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RESULTS

Among the 537 neonatal deaths investigated, 73.6% occurred in the early neonatal period (0-6 days). The mean age of death was 4.96 days. The male gender represented a little more than half of the study population (56.8%) and the caucasian race was predominant (85.4%).

Among the newborns who died during the early neonatal period, 76.0% occured by the second day of life. Of these, 43.0% did not live through the first 24 hours. When the deaths occurred in the late neonatal period, of the total, approximately 53.0% lived more than 14 days.

With regard to maternal characteristics, it was verified (Table 1) that, of all the mothers of the newborns, the young totaled 60.2% (12 to 27 years). Regarding extremes of age, 22.2% were less than 19 years of age and 12.9% were older than 36 years. The mean age of the women was 25.8 years. Approximately 70.0% of the women had more than eight years of education. The mean family income was 3.95 times the minimum wage, and 52.5% had an income up to 4 times minimum wage, while 14.1% received less than the minimum wage.

Slightly more than 50% had paid employment and the majority (82.1%) had a partner. Of these women, 91.4% attended prenatal care. Of these, 55.1% attended up to six visits (Table 1). Maternal and prenatal characteristics analyzed showed no statistically significant association with neonatal death (early or late).

Table 1 – Distribution of maternal and prenatal characteristics and the period of death. 2000-2009, Londrina-PR.

Maternal and prenatal characteristics*	Period of Death				Total		p-value
	0-6 days		7-27 days				
	N	%	N	%	N	%	
	395	100,0	142	100,0	537	100,0	
Age range (in years)							
12-19	85	15.8	33	6.1	118	21.9	>0.05
20-27	158	29.4	47	8.8	205	38.2	
28-35	104	19.4	40	7.4	144	26.8	
36 and more	47	8.7	22	4.1	69	12.8	
Education (in years)							
0-3	33	6.1	10	1.9	43	8.0	>0.05
4-7	81	15.1	40	7.4	121	22. 5	
8-11	207	38.5	66	12.3	273	50.8	
12 and more	72	13.4	24	4.5	96	17.9	
Family income (in minimum wages)							
Up to 1	56	10.4	20	3.7	76	14.1	>0.05
2-4	150	28.0	56	10.4	206	38.4	
5 and more	68	12.7	22	4.1	90	16.8	
Occupation							
Paid	191	35.6	58	10.8	249	46.4	>0.05
Unpaid	195	36.3	82	15.3	277	51.6	
Conjugal situation							
With partner	321	59.8	120	22.3	441	82.1	>0.05
Without partner	67	12.5	20	3.7	87	16.2	
Nr. Consultas de Pré-natal							
1-6	215	40.0	81	15.1	296	55.1	>0.05
7 and more	141	26.3	54	10.0	195	36.3	

*All percentages exclude ignored subjects

Regarding delivery characteristics, it can be seen in Table 2 that slightly more than 50.0% were vaginal deliveries. Of all hospital births, 63.7% were performed in hospitals with maternity and a neonatal intensive care unit (NICU), but about 30.0% were still born in hospitals without specialized neonatal care.

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Approximately 60.0% of newborns were observed to be less than 31 weeks of gestation, and 60.7% weighed less than 1,500 grams. Of these, just over 46.0% died before completing seven days of life. On the other hand, it was found that about 13.0% died in the late neonatal period, again with low birth weight and gestational age (Table 2).

Table 2 – Distribution of birth, birth location, newborn characteristics and the period of death. 2000-2009, Londrina-PR.

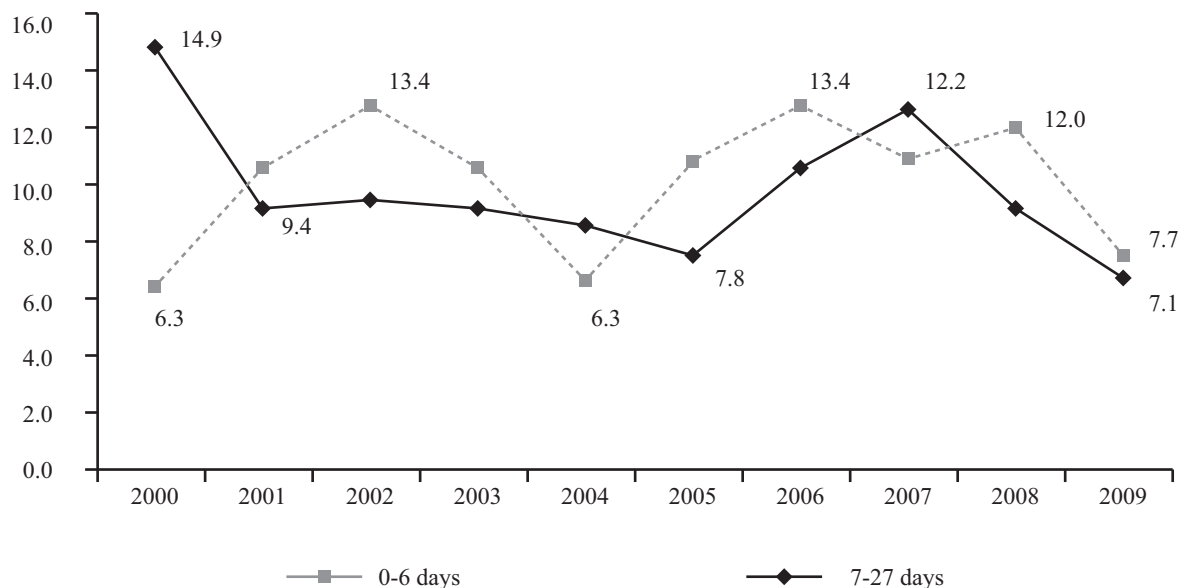| Characteristics of birth, birth location, and the newborn* | Period of Death | | | | Total | | p-Value |
	0-6 days		7-27 days				
	Nº	%	Nº	%	Nº	%	
	395	100.0	142	100.0	537	100.0	
Type of Birth							
Vaginal	211	39.3	64	11.9	275	51.2	>0.05
Cesarean	184	34.3	78	14.5	262	48.8	
Gestational age (in weeks)							
22-26	181	33.7	43	8.0	224	41.7	<0.01
27-31	67	12.5	26	4.8	93	17.3	
32-36	64	12.0	31	5.7	95	17.7	
37 and more	75	14.0	40	7.4	115	21.4	
Birth weight (in grams)							
<1000	201	37.4	52	9.7	253	47.1	<0.01
1000- 1499	53	9.9	20	3.7	73	13.6	
1500- 2499	70	13.0	24	4.5	94	17.5	
>2500	71	13.2	46	8.6	117	21.8	
Apgar score at 1 minute							
Severe asphyxia (<3)	225	41.9	53	9.9	278	51.8	<0.01
Moderate asphyxia (4-6)	85	15.8	29	5.4	114	21.2	
Without asphyxia (>7)	74	13.8	55	10.2	129	24.0	
Apgar score at 5 minutes							
Severe asphyxia (<3)	117	21.8	8	1.5	125	23.3	<0.01
Moderate asphyxia (4-6)	91	16.9	24	4.5	115	21.4	
Without asphyxia (>7)	176	32.8	105	19.5	281	52.3	
Birth location							
Public: Maternity and NICU	155	28.9	58	10.8	213	39.7	<0.01
Public: Maternity	48	9.0	35	6.5	83	15.5	
Philanthropic: Maternity and NICU	102	19.0	27	5.0	129	24.0	
Private: Maternity	75	14.0	18	3.3	93	17.3	
Residence and / or public road	15	2.8	4	0.7	19	3.5	

*All percentages exclude ignored subjects

Also in Table 2, it was verified that 73.0% of newborns presented asphyxiation at one minute of life, and 57.7% died within the first six days. An Apgar score less than seven at five minutes was found in 44.7%. Except for the type of delivery, all variables related to the newborn and place of birth showed significant association with the period of death (early or late).

The neonatal mortality rate decreased, especially the early period, by half, falling from 59 (14.9%) in 2000 to 28 (7.1%) in 2009, but continued to be higher when compared to the late neonatal period (p>0.05). On the other hand, late neonatal deaths increased from 20 (6.3%) in 2000 to 19 (13.4%) in 2006; and fell from 17 (12.0%) in 2008, to 11 (7.7%), in 2009 (Figure 1).

With regard to the cause of death, it can be observed in Table 3 that perinatal conditions (77.7%), in their majority, led to death in the first six days of life of the newborns. In the late neonatal period these causes were also observed (22.3%), in particular, complications of pregnancy, labor and delivery, followed by other maternal morbidities (Table 3).

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Figure 1 – Coefficient of neonatal mortality. 2000-2009, Londrina PR.

Table 3 – Distribution of cause of death and period of death. 2000-2009, Londrina-PR.

Primary Cause of Death	Period of Death				Total	
	0-6 days		7-27 days			
	N	%	N	%	N	%
	395	100.0	142	100.0	537	100.0
CAP. XVI – Perinatal disorders	318	80.5	99	69.7	417	77.6
CAP. XVII - Congenital malformations, deformations and chromosomal abnormalities	73	18.5	34	23.9	107	20.0
CAP. X – Respiratory system diseases	–	–	1	0.7	1	0.2
CAP. XIX Injury, poisoning and certain other consequences of external causes	3	0.8	1	0.7	4	0.7
CAP. XX - External causes of morbidity and mortality	1	0.2	7	4.9	8	1.5

It can also be seen (Table 3) that congenital malformations accounted for 19.9% of basic causes of death in the neonatal period, with 13.6% occurring in the early neonatal and 6.3% in the late neonatal periods. Deaths from external causes were more evident after seven days of life.

Among the criteria for preventability of deaths, it was found that of the total, 72.6% were considered preventable. Those not preventable represented 15.8%, followed by difficult to prevent (10.1%) and inconclusive (1.5%). Table 4 shows that among the classification of preventability, 77.1%

of the deaths were reducible through proper management of pregnancy and childbirth, and 17.5% were reducible through partnerships among healthcare sectors.

Table 4 – Distribution of the classification of preventability (SEADE, 2000). 2000-2009, Londrina-PR.

Classification of preventability	N	%
	537	100.0
Reducible by adequate control of the pregnancy	230	42.9
Reducible by adequate care during labor	184	34.2
Reducible by actions of prevention, diagnosis and early treatment	2	0.4
Reducible by means of partnerships with other sectors	94	17.5
Not preventible	26	4.8
Poorly defined	1	0.2

Fonte: SEADE, 2000.

DISCUSSION

Among the southern states, Rio Grande do Sul, compared with Paraná and Santa Catarina, has the greatest reduction in both the early neonatal component (7.2/1000 LB in 2004, to 5.96/1000 LB in 2007) and the late neonatal period (2.87/1000 LB in 2004 to 2.34/1000 LB in 2007)[4,6,12,13].

In contrast to the states in the southern region, the state of Acre in the northern region showed a significant increase in the coefficient of neonatal deaths, from 15.87/1000 LB, in 2004, to 17.04/1000 LB in 2007. In the states of Maranhão (northeastern region) and Espírito Santo (southeastern region) the reduction was very slow[4].

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The state of Paraná also presented a reduction in births from 192,757 in 1997 to 159,636 in 2004 (17.18%), and from 147,554 (23.45%) in 2007, the equivalent of 23.45% (from 1997 to 2007)[4]. Regarding neonatal mortality in the same period, 1997, 2004 and 2007, in contrast to births, the number of deaths corresponded to 2,312, 1,683 and 1,342, equivalent to the Neonatal Mortality Coefficient of 62.69/1000 LB, 67.89/1000 and 68.82 /1000 LB, respectively. This fact comes from the early neonatal period which, over these years, maintained a value of 68.0 to 76.0% of total deaths up to 27 days of life[4].

The neonatal mortality rate in the state was 10.54/1000 LB in 2004, but this was still three times higher compared to the indices of Japan (3/1000 LB) in the same year. In 2007, it reduced to 9.1/1000 LB[4]. It should be noted that in relation to 2007, the number of deaths increased, even more, in 2008, it rose to 1,390 deaths (70.3%), predominantly in the early neonatal component (71.3%)[4].

The city of Londrina also showed rates of neonatal deaths equivalent to the state. In 1997, 2004 and 2007, there were 60 (56.1%), 43 (67.2%) and 63 (81.8%), respectively. Deaths also predominantly occurred until the sixth day of life, 83.3/1000 LB (50), 79.1 (34) and 77.8/1000 LBs (49), in the same years. It was noted that in 2009, it had dropped to 39 (61.9%).

The relationship between neonatal death and maternal socioeconomic variables, in this study, were not statistically significant. These findings were also observed in the results of other studies[7,10].

Although the relationship between maternal variables was not associated with the early and late deaths, a significant portion of women were identified as extremes of age (12-19, and, $\geq$36), with less than eight years of education, and lower than two minimum wages for income. There were also an insufficient number of prenatal consultations. Other studies have found a positive relationship between such variables, and have called attention to the relationship between reduced maternal socioeconomic conditions, extreme ages and higher rates of neonatal mortality, especially early, due to limited access and inadequate care during pregnancy and childbirth[1,7,11,14,15]. Also, a multicenter study conducted in eight Latin American countries (Argentina, Brazil, Cuba, Ecuador, Mexico, Nicaragua, Paraguay and Peru) in 2005, to identify maternal indicators with maternal morbidity and perinatal death, showed that among the 2,952 women surveyed, 79.8% had attended three to six consults, whereas 17.1% attended less than three[16].

In the present study, preterm labor was prevalent among neonates and just over half were born via vaginal delivery. Most babies who were born prematurely died in the early neonatal period. The highest rates of perinatal mortality were confirmed in other studies conducted in different Brazilian states[8,9,15,17]. These results did not differ from other studies conducted in Latin America, Europe and USA[16,18-20]. In the United Kingdom in 2010, the highest rates of neonatal mortality were related to low birth weight and gestational age less than 31 weeks[21]. In India, 78% (10,892) of neonatal deaths, between 2000 and 2003, resulted from births with low gestational age, low birth weight, neonatal infections and asphyxia[22].

Low birth weight, in particular, is a major factor associated with the risk of death in the neonatal period and is generally associated with biological, social and environmental factors. It is also a predictor for the survival of the newborn in the first 28 days of life. Many studies have pointed to high neonatal mortality due to low birth weight and the high costs during hospitalization in specialized services that could be minimized with effective interventions to increase the length of gestation[3,8,10,11,15,17].

The majority of births occurred in hospitals with maternity and a NICU, but there were still significant births in hospitals that did not provide intensive care for the newborn. Other research showed that the majority of newborns with low birth weight, and children of young mothers with poor socioeconomic conditions, were born in public hospitals with limited accessibility[14-17].

In this study it was also observed that asphyxiation at one minute was greater than 70.0%, and it was considered to be one of the major causes of neonatal death and neurological sequelae in newborns. In general, studies examining neonatal mortality and complications in childbirth/postpartum observed a higher mortality among infants with low birth weight and, arising from the low quality of prenatal and antenatal care, the majority developed infections and respiratory distress syndrome[6,7]. In other countries, infections and respiratory complications were the most frequent causes of very low birth weight newborn deaths.

In San Lorenzo, Paraguay, between 2004 and 2007, almost all newborns born prematurely were admitted to the NICU in the *Centro Materno Infantil do Hospital de Clínicas*[20]. In the urban area of Pakistan-South Asia, between 2003 and 2005, all of the neonatal deaths (1,280) 73.0% occurred in the early neonatal period due to premature birth, 34% from neonatal asphyxia, and 23% due to neonatal infections[18]. In the U.S.A., the relationship between Apgar score and neonatal mortality of preterm newborns, between 2001 and 2002, showed that the increased risk of neonatal anoxia (score 0-6) occurred among newborns with gestational age of 24-28 weeks (average of 6). In pregnancies with 30 to 36 weeks, the mean Apgar score was nine (no anoxia)[19].

In the cases analyzed in this research, the majority were considered *preventable.* These results were also found in studies that investigated the causes of neonatal mortality in different Brazilian regions[6,7,9-11,13,15,17].

Among the primary causes of neonatal death in this study, *perinatal complications of pregnancy, labor* and

childbirth prevailed. The following were among the risk factors associated with these conditions in the literature: prematurity, low birth weight, maternal infection, rupture of membranes, etc. These in turn can be minimized, even during the pregnancy period, with qualitative monitoring and prophylactic antenatal measures[1,5,7-9,11,14,17].

CONCLUSION

Among the characteristics of neonatal mortality in the city, in the ten years of the study, prematurity, low birth weight, low gestational age, an insufficient number of prenatal consults, and deaths in the first six days of life prevailed. Maternal conditions also proved unfavorable, even if not associated with neonatal death. These results reinforce the need to invest in the prevention of preterm labor, with antenatal and delivery care that is equitable, accessible and comprehensive, between different levels of care for maternal and child health. It is worth noting that other research is needed to identify possible gaps in the care provided to pregnant women, and difficulties in executing integrated practices in the health system.

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