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Risk factors for neonatal mortality among children with low birth weight

ABSTRACT

OBJECTIVE: To analyze the risk factors associated with neonatal deaths among children with low birth weight.

METHODS: A cohort study was carried out on live births weighing between 500 g and 2,499 g from single pregnancies without anencephaly in Recife (Northeastern Brazil) between 2001 and 2003. Data on 5,687 live births and 499 neonatal deaths obtained from the Live Birth Information System and the Mortality Information System were integrated through the linkage technique. Using a hierarchical model, variables from the distal level (socioeconomic factors), intermediate level (healthcare factors) and proximal level (biological factors) were subjected to univariate analysis and multivariate logistic regression.

RESULTS: After adjusting the variables through multivariate logistic regression, the factors from the distal level that remained significantly associated with neonatal death were: cohabitation by the parents, number of live births and type of maternity hospital. At the intermediate level, the factors were: number of prenatal consultations, complexity of the maternity hospital and type of delivery. At the proximal level, the factors were: sex, gestational age, birth weight, Apgar score and presence of congenital malformation.

CONCLUSIONS: The main factors associated with neonatal mortality among low weight live births are related to prenatal and postnatal care. Such factors are reducible through health sector actions.

DESCRIPTORS: Infant, Low Birth Weight. Neonatal Mortality (Public Health). Risk Factors. Socioeconomic Factors. Cohort Studies.

INTRODUCTION

Birth weight of less than 2,500 g is recognized as the most influential factor in determining neonatal morbidity-mortality.[16] Low birth weight stems from prematurity and/or delayed intrauterine growth and is associated with around four million neonatal deaths around the world every year, mostly in developing countries.[12]

Neonatal mortality results from a complex chain of biological, socioeconomic and healthcare-related determinants. Over recent years, several authors have analyzed the role of these factors according to hierarchical determinant models in which each grouping of factors presents interference with the others, thus allowing separate and collective understanding of their importance.[10,14,15]

In Brazil, the Mortality Information System (*Sistema de Informação sobre Mortalidade*, SIM) and the Live Birth Information System (*Sistema de Informações sobre Nascidos Vivos*, Sinasc) have been greatly used to study neonatal mortality

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and, especially, its determinants.[6,17] In municipalities in which SIM and Sinasc have adequate coverage and good data quality, important characteristics of neonatal mortality have been observed. This has been seen particularly when these databases are integrated, starting with a variable that is common to the two systems and unambiguous for each case ("key variable"): the Live Birth Declaration (LBD) number. This has been widely used in population-based mortality studies, at low cost.[1,13]

The aim of the present study was to analyze associations between variables coming from Sinasc and neonatal mortality, among low-weight live births.

METHODS

A birth cohort study composed of live births weighing 500 to 2499 g, born to mothers living in Recife, Pernambuco, between January 1, 2001, and December 31, 2003, was conducted. Live births from multiple pregnancies and cases of anencephaly were excluded. Over this period, there were 73,854 births in the city of Recife, of which 5,670 live births were included within the selection criteria. Information on neonatal survival or death was gathered until January 27, 2004.

Data from Sinasc and SIM were gathered from the Municipal Health Department of Recife. These systems present information that is considered "satisfactory" according to the infant mortality indicator monitoring system (MonitorIMI) that has been put into operation by the Oswaldo Cruz Foundation with support from the Ministry of Health.[a]

The 5,670 live births and 537 neonatal deaths constituted two separate databases. As a first step, the EpiInfo 6.04d software was used to integrate these databases deterministically, using the LBD number as the "key". However, the LBDs corresponding to 55 deaths could not be located in the live birth database, and these were investigated in the state Sinasc database and in the hospitals where they occurred.

Initially, the state Sinasc database was consulted. From this, 35 LBDs relating to these 55 deaths were located. According to the LBDs for these children, five were twin live births, two had birth weights of less than 500g and 28 were births to mothers who did not live in Recife. Since these 35 cases did not fulfill the selection criteria adopted for participation in the cohort, they were excluded.

Among the remaining 20 deaths, after investigation in the hospitals where these births and deaths occurred, it was found that three were fetal deaths and the others had not had LBDs issued. These were cases of live births with weights close to 500g in which the infants died within the first hours of life. For these 17 children, LBDs were constructed on the basis of data in the medical records and delivery room books. Thus, these cases were included in the database of live births. The final population forming the study cohort consisted of 5687 live births, of which 499 died within the neonatal period and 5188 survived. These two databases were then correlated to form the final database that was used in this study.

The independent variables relating to the exposure were hierarchically ranked at three determinant levels: distal, intermediate and proximal. The positioning of the variables followed a previously established order based on a model that described the logical or theoretical relationships between the variables with regard to determining the outcome. Thus, at the distal level, the following socioeconomic variables were selected:

- mother's schooling level, in completed years of study;
- mother's conjugal situation, which was categorized as "without a partner" (single, widowed or legally separated) or "with a partner" (living together or married);
- mother's age;
- previous number of live births;
- living conditions in the district where the mother lived. To obtain this variable, the Living Condition Indicator (LCI) for the districts of Recife developed by Guimarães et al.[8] was used. The LCI resulted from synthesis of six socioeconomic and demographic indicators, by means of factorial analysis. Using the LCI, the districts of Recife were grouped into three strata that were obtained via the cluster technique. Thus, the home district of each live birth was categorized as high, intermediate or low, according to the stratum of living conditions to which it belonged;
- poverty density in the home district. Thus, the home district of each live birth was categorized as high, intermediate or low, according to the stratum of poverty density to which it belonged;
- type of hospital where the birth took place, which was categorized as belonging to the Brazilian national health system (*Sistema Único de Saúde*, SUS) or not. This variable was used as a proxy for the family's socioeconomic level. The SUS category included units belonging to SUS and those used through accords, plus three hospitals to which access was restricted to public servants. The non-SUS category included hospitals maintained solely by the private network.

[a] Sistema de Monitoramento dos Indicadores de Mortalidade Infantil [home page on the internet]. Brasília: Fundação Oswaldo Cruz / Ministério da Saúde; 2006 [cited 2006 Jan 12]. Available from: http://www.monitorimi.cict.fiocruz.br/fontes.htm#

At the intermediate level of determinants of neonatal death, variables relating to healthcare were selected: (a) number of prenatal consultations; (b) complexity of the hospital where the birth took place, taking into consideration the presence of a neonatal intensive care unit at the hospital between 2001 and 2003; and (c) type of delivery.

The variables analyzed at the proximal level were: (a) sex; (b) gestational age; (c) birth weight; (d) Apgar score at the first and fifth minutes of life; and (e) evolution of the Apgar score from the first to the fifth minute. To construct this variable, all live births with an Apgar of less than 7 at the fifth minute were considered to present hypoxia and were classified according to the Apgar score at the first minute as severe (between 0 and 3), moderate (between 4 and 6) and mild (7 or more); (f) presence of congenital malfunction.

Some variables available in the Sinasc database, such as the mother's occupation, were not studied because the percentage of unknown information exceeded 5%. The variables that were not obtained directly from the original live birth database (living conditions and poverty density in the district of residence, type and complexity of the hospital where the birth took place, and evolution of the Apgar score) were constructed and added to the database. Aggregation of the levels of the variables was done while taking conceptual notions (epidemiological and clinical) into consideration.

The statistical analyses were performed using the SPSS statistical package, version 12. Firstly, univariate analysis was performed between the independent variables at each level of determination and the neonatal deaths (dependent variable), using logistic regression. Although this was a cohort study, it was decided to present the results using odds ratios (ORs) as the association measurement, with their respective 95% confidence intervals, given that logistic regression would be used in the multivariate model. This measurement has the disadvantage, compared with relative risk, of overestimating the association when the outcome studied presents a high frequency in relation to the exposure. The reference category was defined as the one that would theoretically present least expected risk of neonatal death.

To adjust the ORs, a hierarchical approach to entering the variables was used, in conformity with the three determinant levels defined previously for multivariate logistic regression, using the "enter" method. The variables that presented statistical significance at p-values ≤ 0.20 in the univariate analyses were previously selected for regression analysis, except for the variable of evolution of the Apgar score from the first to the fifth minute of life, since this was constructed from two variables that were already present (Apgar scores at the first and fifth minutes of life). Although the mother's age and the poverty density presented p-values > 0.20, they were included in the model because they were considered to be exposure variables of interest.

The strategy used for adjusting the ORs used the following procedures: firstly, the variables at the distal level (the mother's schooling level, conjugal situation and age; the number of live births; poverty density; and type of hospital where the birth took place) were included in a regression model in order to make adjustments between them. The variables that presented p-values ≤ 0.20 were kept in the model, even if they happened to lose statistical significance through the inclusion of variables from lower levels. This same strategy was maintained with the introduction of variables from the intermediate level (number of prenatal consultations, complexity of the hospital where the birth took place and type of delivery) and from the proximal level (sex, gestational age, birth weight, Apgar at the first and fifth minutes of life and occurrences of congenital malformations), which were adjusted between each other and using the variables from the distal and intermediate levels.

This study was approved by the Research Ethics Committee of *Hospital Oswaldo Cruz*, *Universidade de Pernambuco*.

RESULTS

With regard to the distal determinants of neonatal mortality among children with low birth weight (Table 1), univariate analysis showed that three of the five variables studied (mother's schooling, mother's conjugal situation and type of hospital where the birth took place) presented statistically significant associations, with ORs between 1.39 and 1.82.

With regard to the intermediate determinants (Table 2), all the variables subjected to univariate analysis presented statistically significant ORs, with values between 0.67 (birth in a hospital without a neonatal intensive care unit) and 5.71 (number of prenatal consultations between 0 and 3). In relation to prenatal consultations, OR was seen to decrease with increasing numbers of consultations. At this analytical stage, the protective effect of birth in a hospital without a neonatal intensive care unit was observed.

Among the proximal determinants (Table 3), all the variables presented significant associations with neonatal death. Gestational age, birth weight and the variables relating to Apgar presented the highest OR values. Among the premature live births, gestational age ≤ 31 weeks (OR = 96.94) was the exposure factor with the greatest chance of neonatal death. The birth weight category < 1,500 g (OR = 38.73) also presented a significant chance of neonatal mortality, compared with the weight category from 1,500 to 1,999 g (OR = 3.94). The children whose Apgar evolution from the

Table 1. Distal risk factors (unadjusted) for neonatal mortality among children with low birth weight. Recife, Northeast Brazil, 2001-3.

Variables	Deaths (n=499)[a]	Survivors (n=5188)[b]	Unadjusted OR	95% CI	p
Mother's schooling level (years)					0.11
0 to 3	49	558	1.27	0.85;1.91	
4 to 7	206	2094	1.42	1.03;1.96	
8 to 11	175	1717	1.48	1.07;2.05	
≥12	50	724	1.00		
Mother's conjugal situation					0.001
Without partner	176	1514	1.39	1.14;1.69	
With partner	302	3610	1.00		
Mother's age (years)					0.41
< 20	139	1497	0.93	0.75;1.14	
20 to 34	320	3202	1.00		
≥ 35	39	487	0.80	0.57;1.13	
Nº of live births					0.03
≥ 6	16	93	1.82	1.06;3.12	
0 a 5	478	5065	1.00		
Living conditions					0.99
Low	248	2569	1.02	0.78;1.35	
Intermediate	179	1865	1.02	0.76;1.36	
High	71	752	1.00		
Poverty density					0.32
High	339	3398	1.32	0.92;1.90	
Intermediate	126	1340	1.25	0.84;1.85	
Low	33	448	1.00		
Type of hospital where birth took place					0.01
SUS	434	4293	1.43	1.09;1.89	
Non-SUS	62	879	1.00		

[a] Deaths with unknown variables were excluded: mother's schooling level (19 deaths), conjugal situation (21), mother's age (1), number of live births (5), living conditions (1), poverty density (1), hospital where birth took place (3).

[b] Survivors with unknown variables were excluded: mother's schooling level (95 survivors), conjugal situation (64), mother's age (2), number of live births (30), living conditions (2), poverty density (2), hospital where birth took place (16).

first to the fifth minute of life revealed severe hypoxia presented a chance of death that was 44 times greater than among those without hypoxia.

Table 4 presents the adjusted ORs at the three levels of determination. At the distal level, out of the six variables included in the logistic regression, the mother's schooling level and age and the density of poverty were excluded from the model because they presented p > 0.20. Mothers with six or more live births presented a chance of neonatal death (OR = 1.91) that was greater than the exposure factor among mothers without a partner (OR = 1.38). At the intermediate level, out of the three variables included, all of them presented significant associations with neonatal death after adjustment between each other and for the variables of the distal level. At this level of determinants, number of prenatal consultations between 0 and 3 (OR = 6.63) was the exposure factor with the greatest chance of death. Finally, at the proximal level, all of the six variables included in the model maintained significant associations with the outcome, after adjustment for the variables of the intermediate and distal levels. Children born with a gestational age ≤ 31 weeks presented the exposure factor with the greatest chance of death (OR = 7.89), followed in decreasing order by those born with weight < 1,500 g (OR = 6.87), Apgar between 0 and 3 in the first minute of life (OR = 6.08), presence of congenital malformation (OR = 5.60), Apgar between 0 and 3 in the fifth minute (OR = 4.16) and male sex (OR = 1.64).

DISCUSSION

Several studies in Brazil have addressed the determinants of neonatal mortality.[1,14,15,17] Because of the large social inequalities that exist in this country, it is

Table 2. Intermediate risk factors (unadjusted) for neonatal mortality among children with low birth weight. Recife, Northeast Brazil, 2001-3.

Variables	Deaths (499)[a]	Survivors (5188)[b]	Unadjusted OR	95% CI	p
Nº of prenatal consultations					<0.001
0 to 3	243	1230	5.71	4.28;7.63	
4 to 6	170	2138	2.30	1.70;3.10	
≥ 7	61	1761	1.00		
Complexity of the hospital where birth took place					0.001
Without neonatal ICU	91	1293	0.67	0.53;0.85	
With neonatal ICU	405	3879	1.00		
Type of delivery					<0.001
Vaginal	349	3005	1.65	1.35;2.01	
Cesarean	149	2180	1.00		

[a] Deaths with unknown variables were excluded: number of prenatal consultations (25 deaths), complexity of the hospital where birth took place (3), type of delivery (1).

[b] Survivors with unknown variables were excluded: number of prenatal consultations (59 survivors), complexity of the hospital where birth took place (16), type of delivery (3).

ICU: intensive care unit

important to investigate local risk factors. In the city of Recife, Sarinho et al[20] and Aquino et al[3] analyzed the risk factors for neonatal and perinatal mortality, respectively, using SIM and Sinasc as the data sources. The present study adds to the work produced by those authors by focusing on factors associated with neonatal death among the population of live births with low birth weight, using a hierarchical determination model.

The factors associated with neonatal morbidity are complex, interrelated and common to those that contribute toward low birth weight. It is therefore important to use hierarchical models to study these factors.[5,22]

Among the distal (socioeconomic) determinants analyzed in the present study, the living conditions and poverty density of the district where these newborns lived were not seen to be associated with deaths among low-weight live births. Guimarães et al[8] demonstrated a relationship between neonatal mortality and these variables at the ecological level in Recife. At the individual level, Aquino et al[3] did not find that living conditions in the district were a risk factor for perinatal and infant mortality. This variable was probably not revealed as a risk factor for mortality at the individual level because of the internal heterogeneity presented by the different districts of Recife. Thus, the relationship at the collective level should not be transposed directly to the individual level.

Regarding the relationship between the mother's schooling level and neonatal death, some authors have found that a lower number of years of schooling is a risk factor,[5,9] whereas others have not observed any relationship between the variables.[10,17] In the present study, only the mother's schooling was not associated with neonatal death. Memory bias may have led to imprecision in declaring this variable, in relation to others such as the type of hospital where the birth took place, and this influence may have caused the absence of statistical significance.

In relation to neonatal death, the presence of a partner for the mother is probably reflected in the care given to the newborn, because of the financial contribution and psychosocial support. This has a positive effect on the child's survival, as indicated by Monteiro et al[16] in a study conducted in the city of Sao Paulo. In the present study, the absence of a partner for the mother was seen to be a risk factor at the distal level and it remained a risk factor after analysis.

In the present study, the age group from 20 to 34 years was taken as the reference category for analyzing exposure factors. No association between the mother's age and neonatal death was observed in this age group, unlike what was suggested by Horon et al.[10] This finding probably results from the fact that the population of this cohort was solely composed of children with low birth weight, a condition under which the mother's age is considered to be a risk factor.[7] Thus, among the live births studied, the role of the mother's age was already expressed by means of the low birth weight.

The low-weight newborns whose mothers had already had six or more live births presented greater risk of neonatal death in the univariate and multivariate analyses. This finding among children with low birth weight may be explained by the occurrence of shorter intervals between the deliveries.[2]

Table 3. Proximal risk factors (unadjusted) for neonatal mortality among children with low birth weight. Recife, Northeast Brazil, 2001-3.

Variables	Deaths (499)[a]	Survivors (5188)[b]	Unadjusted OR	95% CI	p
Sex					<0.001
Male	282	2288	1.65	1.37;1.99	
Female	216	2896	1.00		
Gestational age (weeks)					<0.001
≤ 31	316	351	96.94	62.03;151.50	
32 to 36	154	2447	6.78	4.32;10.63	
≥ 37	22	2369	1.00		
Birth weight (g)					<0.001
< 1500	351	455	38.73	29.68;50.56	
1500-1999	72	917	3.94	2.32;5.11	
2000-2499	76	3816	1.00		
Apgar at 1st minute					<0.001
0 to 3	229	184	46.78	35.73;61.24	
4 to 6	127	653	7.31	5.60;9.54	
7 to 10	113	4247	1.00		
Apgar at 5th minute					<0.001
0 to 3	106	31	69.58	45.70;105.93	
4 to 6	125	134	18.98	14.41;25.03	
7 to 10	244	4965	1.00		
Evolution of Apgar					
Severe hypoxia	194	88	44.87	33.82;59.53	<0.001
Mild/moderate hypoxia	34	69	10.03	6.52;15.42	
No hypoxia	244	4966	1.00		
Congenital malformation					<0.001
Present	58	113	5.92	4.25;8.24	
Absent	440	5073	1.00		

[a] Deaths with unknown variables were excluded: sex (1 death), gestational age (7), birth weight (1), Apgar at 1st minute (30), Apgar at 5th minute (24), evolution of Apgar (27), congenital malformation (1).

[b] Survivors with unknown variables were excluded: sex (4 survivors), gestational age (21), Apgar at 1st minute (104), Apgar at 5th minute (58), evolution of Apgar (65), congenital malformation (2).

Birth in a hospital belonging to the SUS network was seen to be a risk factor for neonatal mortality among children with low birth weight, at the distal level and after adjustment for the exposure factors of the other determination levels. A similar result was found by Morais Neto & Barros in Goiânia (State of Goiás) for all newborns, regardless of birth weight.[17] Along with reflecting the family's socioeconomic situation, this association suggests that high-risk pregnancies and newborns (such as cases of low birth weight) have limited access to obstetric and neonatal interventions of greater complexity.

An apparent controversy was found in relation to the complexity of the hospital where the birth took place (intermediate determinant): univariate and multivariate analyses showed that absence of a neonatal intensive care unit was a statistically significant protective factor for neonatal death. It is likely that, in hospitals with neonatal intensive care units, the greater occurrence of neonatal deaths is mainly related to the characteristics of the population attended, which consists of high-risk pregnant women and newborns.[19]

Additionally, with regard to care for pregnant women and newborns, many difficulties have been reported in Brazil, such as inequality of access, disorganization and fragmentation of the healthcare system, and technical-scientific inadequacies in the care provided. Concerning prenatal care, hierarchical provision, guaranteed access and quality of care (and not just the quantity of consultations) are undoubtedly key points for improving the care provided.[22] As observed by other authors,[12,18] the present study found that there was a direct relationship between greater numbers of consultations during pregnancy and decreased neonatal mortality.

Table 4. Hierarchical logistic regression on the determining factors for neonatal mortality among children with low birth weight. Recife, Northeast Brazil, 2001-3.

Level	Deaths	Survivors	Adjusted OR	95% CI	p
Distal					
Mother's conjugal situation					0.002
Without partner	176	1514	1.38	1.13;1.68	
With partner	302	3610	1.00		
No of live births					0,03
≥ 6	16	93	1.91	1.07;3.41	
0 to 5	478	5065	1.00		
Type of hospital where birth took place					0.03
SUS	434	4293	1.46	1.05;2.04	
Non-SUS	62	879	1.00		
Intermediate					
No. of prenatal consultations					<0.001
0 to 3	243	1230	6.63	4.62 to 9.50	
4 to 6	170	2138	2.73	1.92 to 3.87	
≥ 7	61	1761	1.00		
Complexity of the hospital where birth took place					0.001
Without neonatal ICU	91	1293	0.65	0.50;0.84	
With neonatal ICU	405	3879	1.00		
Type of delivery					0.006
Vaginal	349	3005	1.37	1.09;1.72	
Cesarean	149	2180	1.00		
Proximal					
Sex					<0.001
Male	282	2288	1.64	1.26;2.14	
Female	216	2896	1.00		
Gestational age (weeks)					<0.001
≤ 31	316	351	7.89	4.27;14.59	
32 to 36	154	2447	3.30	1.97;5.55	
≥ 37	22	2369	1.00		
Birth weight (g)					<0,001
< 1500	351	455	6.87	4.43;10.65	
1500 to 1999	72	917	1.86	1.24;2.79	
2000 to 2499	76	3816	1.00		
Apgar at 1st minute					<0.001
0 to 3	229	184	6.08	3.90;9.49	
4 to 6	127	653	2.97	2.15;4.08	
7 to 10	113	4247	1.00		
Apgar at 5th minute					<0,001
0 to 3	106	31	4.16	2.21;7.85	
4 to 6	125	134	2.51	1.64;3.85	
7 to 10	244	4965	1.00		
Congenital malformation					<0.001
Present	58	113	5.60	3.38;9.26	
Absent	440	5073	1.00		

Distal level: adjusted for mother's schooling level and age and for poverty density
Intermediate level: adjusted for the variables of this level and of the distal level
Proximal level: adjusted for the variables of this level and of the distal and intermediate levels
The variables that did not present statistically significant OR ($p < 0.05$) are not shown in the Table. These were: at the intermediate level, complexity of the hospital where birth took place (with or without neonatal ICU); and at the proximal level, the mother's age (< 35 years or 35 years and over).

The gestational age of the majority of the children studied (57.7%) was less than 37 weeks, which probably had an influence on the lower number of prenatal consultations. Nevertheless, fewer than seven prenatal consultations remained a risk factor after adjustment for the other intermediate-level exposure factors and for factors from the other levels, including gestational age.

Several Brazilian studies have shown that normal delivery is associated with greater neonatal mortality than is observed with cesarean delivery.[6,17,21] This association can be attributed to the poor quality of care for vaginal delivery, the high incidence of cesarean delivery in Brazil and the distortions in indicating the delivery method, such that cesarean delivery is performed on low-risk pregnant women and vaginal deliveries on women at high risk of neonatal death.[6,18] In the municipality of Goiânia (State of Goiás), the protective effect of cesarean delivery was concentrated on children with low birth weight and on those in private hospitals. The clientele of the private hospitals presented better socioeconomic conditions and had other characteristics that favored survival during the neonatal period.[6] The protective effect of surgical delivery may be related to other factors such as type of access to healthcare services and delivery care.[19] In the present study, which was restricted to live births with low weight, vaginal delivery was a risk factor for neonatal mortality, even after adjusting for other exposure factors, such as hospital type, gestational age and birth weight range. Other types of study relating to health service evaluation might elucidate these results regarding delivery method more appropriately.

Male sex represented a risk of neonatal mortality that was around 1.6 times greater. This remained significant after adjusting for the other study variables, thus ratifying the results found by other authors.[4,21] The protective factor of female sex is attributed to the faster maturation of the lungs and consequent fewer respiratory complications.

Among the proximal determinants studied, it was observed that gestational age and birth weight played roles. In the univariate analysis, the high risk of death among live births weighing less than 1,500 g may have been related to the young gestational age. Even after adjustment by means of logistic regression with variables from all determination levels, weight less than 2000 g and gestational age less than 37 weeks remained important risk factors for neonatal death, in the same way as found in other studies.[14,15]

As observed by other authors,[13,21,22] the Apgar score was an important risk factor for neonatal mortality. This finding stresses the role of organizing obstetric and neonatal care towards minimizing the factors that could lead to perinatal hypoxia and consequent neonatal death.

Children with congenital malformations presented greater incidence of death than did those without this factor. This result was similar to findings from Blumenau, by Santa Helena et al.[19] In the present study, the type of malformation was not characterized, except for anencephaly, since this malformation is in principle incompatible with life, and such infants were excluded from the cohort. It is likely that there would have been greater association between malformations and neonatal death if all the cases of more severe organic dysfunction had been categorized separately.

Although the factors that lead to neonatal death are varied and interact with each other with different intensities, it is possible to use the Sinasc and SIM information systems for studying the influence of different variables that determine mortality during the first weeks of life. The present study provides the public authorities with the elements to address this problem at local level. Among the risk factors identified, the importance of those relating to healthcare for pregnant women and newborns can be seen. These can be reduced through actions within the healthcare sector. It is therefore necessary to look more deeply into prenatal, delivery and newborn care. It is also fundamentally important to evaluate the structure of the perinatal care network and the quality of care offered by the municipality.

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