

Factors associated with hospitalization and neonatal mortality in a cohort of newborns from the Unified Health System in São Paulo

Fatores associados à internação e à mortalidade neonatal em uma coorte de recém-nascidos do Sistema Único de Saúde, no município de São Paulo

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ABSTRACT: *Introduction:* Newborn care is an important factor associated with hospitalization and neonatal mortality. *Objective:* To analyze factors associated with hospitalization and neonatal mortality of newborns (NBs) admitted to the Unified Health System (SUS), São Paulo, 2012. *Methods:* A cohort of NBs from the SUS was obtained by linking data: SUS Hospital Information System, Live Birth Information System, Mortality Information System and National Health Facility Registry. Poisson and Cox regression were performed. *Results:* 16.5% (9,127) of the NBs were hospitalized, 4.7% (2,613) were admitted to a Neonatal Intensive Care Unit (NICU) and 11.8% (6,514) to a Neonatal Intermediate Care Unit (NIMCU). Maternal age ≥ 35 years (RR = 1.1, IC95% 1.1 – 1.2), inadequate prenatal care (RR = 1.2, IC95% 1.1 – 1.3), hospitalization for obstetric complications (RR = 1.1, IC95% 1.1 – 1.2), prematurity (≤ 32 weeks: RR = 1.6, IC95% 1.5 – 1.8; 32 to 36 weeks: RR = 1.7, IC95% 1.6 – 1.7), low weight ($< 1,500$ g: RR = 2.4, IC95% 2.1 – 2.6; 1,500 to 2,499 g: RR = 2.6, IC95% 2.5 – 2.7), APGAR 5° < 7 (RR = 1.9, IC95% 1.7 – 2.0), Cesarean section (RR = 1.1, IC95% 1.1 – 1.2) and Congenital Malformation (RR = 1.4, IC95% 1.3 – 1.5) were associated with the hospitalization of newborns. Neonatal mortality was associated with infants under 1,500 g (RR = 9.1, IC95% 6.3 – 13.1), very premature (RR = 2.6, IC95% 1.9 – 3.5), low APGAR (RR = 5.5, IC95% 4.6 – 6.7). *Conclusion:* Inadequate prenatal care, prematurity and low weight were risk factors for hospitalization and neonatal mortality.

Keywords: Intensive Care Units, Neonatal. Neonatal mortality. Cohort Studies. Unique Health System.

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RESUMO: *Introdução:* A assistência prestada ao recém-nascido é importante fator associado à internação e à mortalidade neonatal. *Objetivo:* Analisar fatores associados à hospitalização e à mortalidade neonatal dos recém-nascidos (RN) internados no Sistema Único de Saúde (SUS) em São Paulo, 2012. *Métodos:* Obteve-se coorte de RN do SUS, com base na vinculação dos dados do Sistema de Informações Hospitalares do SUS, Sistema de Informações sobre Nascido Vivo, Sistema de Informação sobre Mortalidade e Cadastro Nacional de Estabelecimentos de Saúde. Realizou-se regressão de Poisson e de Cox. *Resultados:* 16,5% (9.127) dos RN foram internados, 4,7% (2.613) em Unidade de Terapia Intensiva Neonatal (UTIN) e 11,8% (6.514) em Unidade de Cuidado Intermediário Neonatal (UCIN). Idade materna ≥ 35 anos (risco relativo — RR = 1,1, intervalo de confiança de 95% — IC95% 1,1 – 1,2), pré-natal inadequado (RR = 1,2, IC95% 1,1 – 1,3), internação por complicações obstétricas (RR = 1,1, IC95% 1,1 – 1,2), prematuridade (≤ 32 semanas: RR = 1,6, IC95% 1,5 – 1,8; 32 a 36 semanas: RR = 1,7, IC95% 1,6 – 1,7), baixo peso (< 1.500 g: RR = 2,4, IC95% 2,1 – 2,6; 1.500 a 2.499 g: RR = 2,6, IC95% 2,5 – 2,7), APGAR 5° < 7 (RR = 1,9, IC95% 1,7 – 2), parto cesáreo (RR = 1,1, IC95% 1,1 – 1,2) e malformação congênita (RR = 1,4, IC95% 1,3 – 1,5) associaram-se à internação dos RN. A mortalidade neonatal associou-se aos RN com menos de 1.500 g (RR = 9,1, IC95% 6,3 – 13,1), muito prematuros (RR = 2,6, IC95% 1,9 – 3,5), com baixo Apgar (RR = 5,5, IC95% 4,6 – 6,7). *Conclusão:* Pré-natal inadequado, prematuridade e baixo peso foram fatores de risco para hospitalização e mortalidade neonatal.

Palavras-chave: Unidade de terapia intensiva neonatal. Mortalidade neonatal. Estudos de coortes. Sistema Único de Saúde.

INTRODUCTION

With infant mortality declines, neonatal mortality has become the main component of death of children under one year of age¹. In Brazil, 99.3% of births occur in health facilities² where obstetric and neonatal care plays an important role in neonatal mortality.

Factors that cause hospitalization of pregnant women, such as obstetric complications³, inadequate prenatal care³, cesarean delivery, vaginal bleeding^{4,5}, low education⁶ and premature births, with low weight and congenital malformation^{3,5}, are associated with neonatal mortality.

Most studies on this topic in the country are carried out based on secondary data^{3,4} originating from the Mortality Information System (*Sistema de Informação sobre Mortalidade – SIM*) and the Live Birth Information System (*Sistema de Informações sobre Nascidos Vivos – SINASC*), which do not have data on the care received by newborns (NB) or their mothers during pregnancy. Other studies used primary data^{6,7} and reported the admission of pregnant women or maternal morbidity to the neonatal mortality causality network.

The Unified Health System (*Sistema Único de Saúde – SUS*) is responsible for 72.1%⁸ of births in the country and, even in places where supplementary assistance is more present, as is the case in the city of São Paulo, SUS² accounts for 64% of births. A study carried out in the metropolitan region of São Paulo found that the neonatal mortality rate was higher in hospitals in the SUS network, when compared to private ones⁹, and that part of the excess

mortality observed in the SUS network could be attributed to the higher frequency of very low weight (< 1,500 g) and very premature (< 32 weeks) NB.

There is a lack of population studies that indicate the number of NB who are admitted to the Neonatal Intensive Care Unit (NICU) or to the Intermediate Care Unit (NIMCU) in the SUS network. National studies on neonatal mortality of NB admitted to the NICU are restricted to tertiary referral hospitals^{10,11}, which do not necessarily reflect the conditions of much of the delivery care provided in the SUS network. Little is known about the frequency, the risk factors for NB hospitalization, and the neonatal mortality in SUS hospitals.

However, information about hospital morbidity of pregnant women and NB is available in the SUS Hospital Information System (*Sistema de Informações Hospitalares do SUS – SIH/SUS*). This study aimed to identify the factors associated with the admission of NB to the SUS network and neonatal mortality in the city of São Paulo, in 2012.

METHODS

A cohort of hospital live births was studied and obtained from a cohort of pregnant women using SUS and living in the city of São Paulo in the second half of 2012. The definition of the International Classification of Diseases — 10th Revision (ICD-10) was adopted¹², which considers that all births that shows vital signs at birth is born alive, regardless of weight and gestational age.

The cohort of pregnant women was obtained based on the link between the data from the SINASC live birth certificate (LBC), the number of the National Registry of Health Facilities (*Cadastro Nacional de Estabelecimentos de Saúde – CNES*) of the hospital of childbirth (public and mixed), of admissions (Hospital Admission Authorization – HAA) occurred during pregnancy and childbirth (SIH/SUS), NB's hospitalizations after delivery (SIH/SUS), and SIM death certificates.

The cohort of live births includes births which occurred in public SUS hospitals and private accredited SUS ones. The latter were identified based on the link between LBC and delivery HAA. Births in accredited hospitals were excluded from the study, whose LBC were not paired with the childbirth HAA, as they correspond to births financed by the private or supplementary health sectors. Non-hospital births and those occurring in private hospitals, identified based on their registration with CNES, were suppressed.

Delivery hospitalizations were linked to obstetric complications hospitalizations pregnancy hospitalization in which only for those resulting from (Chapter XV: Pregnancy, Childbirth and Puerperium of the ICD-10), within the previous 42 weeks (August 11th, 2011 to December 30th, 2012).

Deterministic and probabilistic techniques were used to link the databases. The univocal identifiers used in the deterministic links were the numbers of the national health register of the pregnant woman (SUS number), the LBC, and the previous hospitalization. The SUS number was used to form the pairs for childbirth HAA and LBC, and hospitalization for childbirth

and hospitalization due to obstetric complications. The LBC number was used in connection with the neonatal death certificate (DC). The number of previous hospitalizations was a unique identifier to pair up hospitalization for childbirth and hospitalization of the NB. In the probabilistic linkage, the databases were standardized and the blocking routine was carried out in multiple steps¹³. The variables used for comparison were: date of birth, age, and the mother's full name; and the soundex of the first and last names, CNES number, district of residence, zip code of residence, gender, and date of birth of the newborn were the variables used in locking keys.

After the linkage, 50,715 live births were identified in hospitals with exclusive SUS care and 5,626 in hospitals affiliated with SUS. 970 childbirth HAA were not identified, which corresponded to a loss of cohort information of 1.7%¹⁴. It was possible to link 97.7% of childbirth HAA, 98.1% of NB HAA, 96.4% of LBC, and 99.6% of DC to form the cohort.

The cohort is composed of hospital live births from June 1st, 2012 to December 31th, 2012. The analysis of neonatal mortality considered the period from June 1st, 2012 to January 27th, 2013. Next, the LBC were linked to the NB HAA within a period of up to 27 days after delivery.

Deterministic links were made using the Stata 13 program (Stata Corp., College Station, the United States) and probabilistic links were made using OpenRecLink¹³.

STUDY VARIABLES

The variables hospitalization due to obstetric complications (yes, no) and hospitalized NB (NICU, NIMCU, and non-hospitalized) were obtained in the HAA of childbirth and NB hospitalizations.

The variables race-color (White, non-White), maternal age in years (< 20, from 20 to 34 and ≥ 35); marital status (with a partner, without a partner); maternal education in years of study (< 8, ≥ 8); parity (0, 1 to 3, 4 or more children); previous fetal loss (yes, no); type of pregnancy (single or multiple); number of prenatal consultations (< 4, 4 to 6, ≥ 7); pregnancy duration in weeks (< 32, 32 to 36, ≥ 37); type of delivery (vaginal, cesarean); type of fetus presentation (cephalic, pelvic or transverse); gender of the NB (female, male), birth weight in grams (< 1,500, 1,500 to 2,499, ≥ 2,500), 5-minute Apgar score (< 7, ≥ 7) and congenital malformation (yes, no) were collected from the LBC.

The non-White/Caucasian category was made up of the sum of the black, yellow, brown and indigenous categories.

DATA ANALYSIS

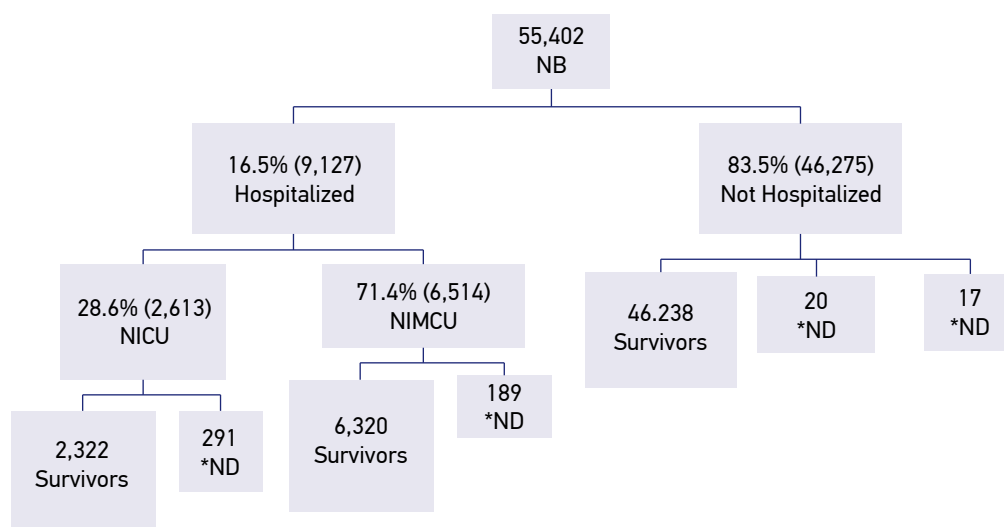
The Poisson regression¹⁵ was used to verify factors associated with the hospitalization of NB, based on the estimate of the relative gross and adjusted risks with the respective 95% confidence intervals (95% CI)¹⁵. The evaluation of mortality strength over time for hospitalized NB was performed by calculating the hazard ratio (HR), or failure rate. A bivariate analysis was performed with the calculation of the gross HR, with the respective 95%CI. The effect of variables on the strength of neonatal mortality was measured by survival

analysis, using the semi-parametric model of proportional hazards (Cox regression)¹⁶. For both models, the criterion for the permanence of the variables in the final model was a value of $p < 0.05$, except for the existence of variables that acted as the model's adjustment.

RESULTS

SUS was responsible for 66% of live births in 2012, in the city of São Paulo; of the total of 55,402 births, 16.5% (9,127) were hospitalized, of which 28.6% (2,613) in NICU and 71.4% (6,514) in NIMCU. In total, there were 517 neonatal deaths, distributed as follows: 291 NB admitted to the NICU, 189 in the NIMCU, 20 in the delivery room and 17 after hospital discharge (Figure 1).

The risk of neonatal hospitalization was higher for births to mothers aged ≥ 35 years old, less education (< 8 years), large multiparous women and with previous fetal loss, and was lower among births to non-White / Caucasian mothers (Table 1). Live births from multiple pregnancies, with an inadequate number of prenatal consultations, fetuses in a non-cephalic position, and pregnant women who had been hospitalized before delivery due to obstetric complications had a higher risk of being admitted after delivery. Hospitalization risks were higher for premature births, with low birth weight, with Apgar score at 5 minutes < 7 , and with congenital malformation (Table 1).



*ND: neonatal deaths.

Source: Raw data from the Live Birth Information System (SINASC)¹⁷, SUS Hospital Information System (SIH/SUS)¹⁸, Mortality Information System (SIM)¹⁹.

Figure 1. Cohort of newborns (NB) from the Unified Health System (SUS), according to admission to the neonatal intensive care unit (NICU) and the neonatal intermediate care unit (NIMCU), from June to December 2012, municipality of São Paulo.

Table 1. Factors associated with the admission of newborns to the Unified Health System (SUS), from June to December 2012, in the city of São Paulo.

Characteristics	NB	HNB	GRR	95%CI	ARR	95%CI
Mothers' age (years)						
< 20	11,110	1,840	1	1.0 – 1.1		
20 to 34	38,128	6,053	1			
≥ 35	6,164	1,234	1.3	1.0 – 1.3	1.1	1.1 – 1.2
Race/color						
Non-White/ Caucasian	33,164	5,211	0.9	0.1 – 0.9	0.9	0.8 – 0.9
White/Caucasian	22,238	3,916	1			
Prenatal (number of medical appointments)						
< 4	4,937	1,351	1.8	2.0 – 1.9	1.2	1.1 – 1.3
4 to 6	12,515	2,396	1.3	1.0 – 1.3		
≥ 7	37,950	5,380	1			
Hospitalization due to obstetric complications						
Yes	52,585	774	1.6	1.5 – 1.7	1.1	1.1 – 1.2
No	2,817	8,353	1			
Type of delivery						
Vaginal	37,181	5,394	1			
Cesarean	18,221	3,733	1.3	1.3 – 1.4	1.1	1.1 – 1.2
Gestational age (in weeks)						
≤ 32	994	818	4.8	5.0 – 5.1	1.6	1.5 – 1.8
32 to 36	5,397	2,199	3.7	4.0 – 3.9	1.7	1.6 – 1.7
≥ 37	49,011	6,110	1			
Weight (grams)						
< 1.500	880	777	5.2	5.0 – 5.6	2.4	2.1 – 2.6
1.500–2.499	4,391	2,251	3.7	4.0 – 3.9	2.6	2.5 – 2.7
≥ 2.499	50,131	6,099	1			
APGAR at 5 minutes						
< 7	695	524	3.8	4.0 – 4.1	1.9	1.7 – 2.0
≥ 7	54,707	8,603	1			
Congenital malformation						
Yes	1,013	387	2.1	2.0 – 2.3	1.4	1.3 – 1.5
No	54,389	8,740	1			

NB: newborn; HNB: hospitalized newborn; GRR: gross relative risk; 95%CI: 95% confidence interval; ARR: adjusted relative risk. Source: Raw data from the Live Birth Information System (SINASC)¹⁷, Mortality Information System (SIM)¹⁸.

After adjusting for the presence of all analyzed variables, the following risk factors remained for the hospitalization of NB: maternal age ≥ 35 years, less than four prenatal visits, maternal hospitalization due to obstetric complications, cesarean delivery, premature births, low weight, Apgar at 5 minutes < 7 , and congenital malformation. Births to non-White/Caucasian mothers had a lower risk of hospitalization (Table 1).

NB admitted to the NICU had a more unfavorable profile when compared to the others. Of the total live births in the cohort, the proportion of those with very low birth weight was 1.6% (880/55,402), while it was 13 times more frequent in NB admitted to the NICU and twice as high in those admitted to the NIMCU. The frequency of premature NB (< 37 weeks) in the cohort was 11.5% (1,391/55,402), among NB admitted to the NICU it was 55.1% (1,466/2,613) and, in NIMCU, 24.3% (1,551/6,514). It was also found that the proportion of very premature NB (< 32 weeks) admitted to the NICU was 12 times more frequent than that of the total cohort. However, it was observed that 11.7% of NB (103/880) with very low birth weight and 17.7% of very premature ones (176/994) were not admitted to the NICU nor to the NIMCU. As a consequence of the more unfavorable profile of NB

Table 2 - Characteristics of newborns in the Unified Health System (SUS), according to hospitalization conditions, from June to December 2012, in the city of São Paulo.

Characteristics	NICU		NIMCU		Not hospitalized		Total
	(N = 2,613)	%	(N = 6,514)	%	(N = 46,275)	%	(N = 55,402)
Gender							
Male	1,415	5.0	3,459	12.3	23,324	82.7	28,198
Female	1,198	4.4	3,055	11.2	22,951	84.4	27,204
Weight (grams)							
< 1.500	546	62.0	231	26.2	103	11.7	880
1.500 – 2.499	893	20.3	1,358	30.9	2,140	48.7	4,391
≥ 2.500	1,174	2.3	4,925	9.8	44,032	87.8	50,131
Gestational age							
< 32	557	56.0	261	26.3	176	17.7	994
32 to 36	909	16.8	1,290	23.9	3,198	59.3	5,397
≥ 37	1,147	2.3	4,963	10.1	42,901	87.5	49,011
Apgar at 5 minutes							
< 7	329	47.3	195	28.1	171	24.6	695
≥ 7	2,284	4.2	6,319	11.5	46,104	84.3	54,707

NICU: neonatal intensive care unit; NIMCU: neonatal intermediate care unit.

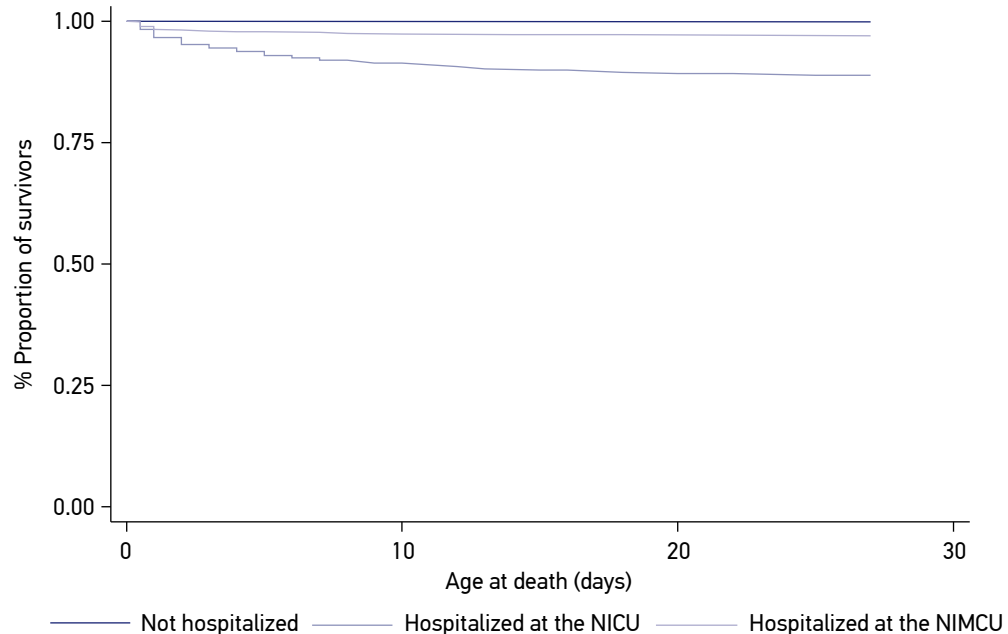
Source: Raw data from the Live Birth Information System (SINASC)¹⁷, Mortality Information System (SIM)¹⁸.

admitted to the NICU and the NIMCU, there was a higher frequency of low Apgar scores below 7 in these NB (Table 2).

In the cohort, the probability of neonatal death was 9.3 deaths per thousand live births, and the incidence was $\lambda = 0.00034824$ infant deaths/day (95%CI 0.0003195 – 0.0003796). Deaths of NB admitted to the NICU accounted for 56.3% (291) of neonatal deaths. Neonatal mortality for NB admitted to the NICU was 111.4 deaths per thousand live births, with a probability of death of $\lambda = 0.0045$ (95%CI 0.0040 – 0.0050). In NIMCU, it was 29.9 deaths per thousand live births, with a probability of death of $\lambda = 0.0011$ (95%CI 0.0009 – 0.0012). Neonatal mortality among NB who were not hospitalized after delivery was 0.7 per thousand live births. Neonatal mortality was 3.8 times higher among newborns admitted to the NICU when compared to those admitted to the NIMCU, with a concentration of deaths in the first days of life (Figure 2).

Considering the total number of hospitalized (NICU and NIMCU) NB (9,127), there were 497 neonatal deaths. An increase in the mortality strength was identified with the reduction of gestational age and birth weight. Neonatal mortality was higher in births to mothers with multiple pregnancies, fetuses in a transverse or pelvic position (data not shown), who had an inadequate number of prenatal visits and were hospitalized due to pregnancy complications (Table 3).

The presence of congenital malformations in the cohort was 1.8, and almost all of them had Apgar score at 5 minutes < 7. In the first 24 hours after delivery, 132 deaths occurred.



*Log-rank test: $p < 0.001$; NICU: neonatal intensive care unit; NIMCU: neonatal intermediate care unit.

Source: Raw data from the Live Birth Information System (SINASC)¹⁷, Mortality Information System (SIM)¹⁸.

Figure 2. Survival according to hospitalization for newborns in the cohort of live births of the Unified Health System (SUS), from June to December 2012, in the city of São Paulo*.

Twenty of them took place in the first 12 hours and without hospitalization, of which 13 (65.0%) had congenital malformations.

The variables maintained in the final model were: births of multiple pregnancies, mothers with less than four prenatal consultations, very premature deliveries (≤ 32 weeks gestation), birth weight $< 1,500$ g, Apgar at 5 minutes ≤ 7 and presence of congenital malformation. Twin births were more susceptible to negative outcomes, with the risk increased by 50% when compared to NB with single pregnancies and controlled by the other variables

Table 3. Neonatal mortality (NM), gross hazard ratio (GHR), adjusted hazard ratio (AHR), 95% confidence interval (95%CI) for live births (LB) in the Unified Health System (SUS) hospitalized in São Paulo.

Characteristics	LB	NM	GHR	95%CI	AHR	95%CI
Prenatal (Number of medical appointments)						
< 4	1,351	173	5.6	4.5 – 6.9	1.2	1.1 – 1.5
4 to 6	2,396	180	3.1	2.5 – 3.9		
≥ 7	5,380	127	1			
Gestational age (weeks)						
≤ 32	818	306	25.5	21.0 – 32.0	2.6	1.9 – 3.5
32 to 36	2,199	67	1.7	1.2 – 2.3		
≥ 37	6,110	107	1			
Weight (grams)						
< 1.500	777	328	34.4	28.0 – 43.0	9.1	6.3 – 13.0
1.500–2.499	2,251	61	1.8	1.3 – 2.4		
≥ 2.499	6,099	91	1			
Apgar at 5 minutes						
< 7	524	206	16.2	14.0 – 19.0	5.5	4.6 – 6.7
≥ 7	8,603	274	1			
Pregnancy						
Single	8,727	428	1			
Multiple	400	52	2.9	2.2 – 3.9	1.5	1.2 – 2.1
Congenital malformation						
Yes	387	115	8.3	6.7 – 10.0	6.4	5.2 – 7.9
No	8,740	365	1			

Source: Raw data from the Live Birth Information System (SINASC)¹⁷, National Registry of Health Facilities (CNES), SUS Hospital Information System (SIH/SUS)¹⁸, Mortality Information System (SIM)¹⁹.

of the model. Births to mothers with four or fewer prenatal visits had a 20% increased risk of neonatal death. Patients with congenital malformation had a five times higher risk of death when compared to non-carriers (Table 3).

Mothers aged 35 years old or older and previous hospitalization due to obstetric complications were significant for NB hospitalization; however, these variables were no longer statistically significant for the occurrence of neonatal death when the variables that were more proximal to those portraying the characteristics of the NB were introduced in the model, such as gestational age and birth weight (Table 3).

DISCUSSION

This study used secondary data, and it shows the panorama of pregnant women and NB care in the SUS network in the city of São Paulo. Of the total NB in the cohort, 16.5% were hospitalized, of which 4.7% were in NICU and 11.8% in NIMCU. The factors associated with NB hospitalization were: mothers aged 35 old and older, inadequate prenatal care, obstetric complications, cesarean delivery, prematurity, low weight, Apgar < 7, and presence of congenital malformation. Neonates of non-White/Caucasian mothers were less frequently hospitalized. With regard to neonatal mortality of hospitalized neonates, only the proximal variables represented by the NB's conditions were associated with the outcome (multiple pregnancies, low birth weight fetuses, gestational age less than 32 weeks, presence of congenital malformation and low Apgar score). The only exception was the association found between mothers with inadequate prenatal care and neonatal mortality.

There was an association between advanced maternal age and hospitalization of NB. This condition has been associated with different pregnancy complications, such as intra-uterine growth retardation, pre-eclampsia, premature placental rupture, premature births, and fetal deaths²⁰⁻²². It is likely that the effect of maternal age on the increased risk of hospitalization of the newborn occurs indirectly. In other words, changes resulting from the mother's age may anticipate delivery, resulting in premature births²³ and very low birth weight²⁴, which have a greater need for hospitalization.

Maternal complications during pregnancy have been associated with an increased risk of hospitalization for NB^{3-5,25,26}. This result supports the hypothesis that there is a relationship between the mother's and the NB's health conditions²⁵, however other important factors were not addressed in this study, such as abnormalities in the placenta, which can change the mother's health status and affect the number of premature births, increasing the possibility of hospitalization of the NB after delivery²⁶.

Maternal hospitalization due to obstetric complications increased the risk of NB hospitalization, regardless of other risk factors, but did not contribute to the increased risk of neonatal death. Therefore, hospitalization of the mother prior to delivery can be understood by health services as a marker of the need for hospital care for NB after delivery.

Live births to non-White/Caucasian pregnant women had a lower risk of admission after delivery than those of mothers declared to be White/Caucasian. This result can express the difficulty of NB of non-White/Caucasian pregnant women in obtaining intensive and semi-intensive care. The same is true for the higher frequency of inadequate prenatal care and maternal follow-up for childbirth among non-White/Caucasian women²⁷, identified in a previous study.

The percentage of NB admitted to the NICU was practically half of what was identified in Canada²⁵ and California²⁸, where this percentage was, respectively, 12 and 10%. The lower frequency of NB admitted to the NICU of the SUS cohort is possibly due to differences in the organization and access to obstetric and perinatal care, as well as in the profile of the population covered, such as, for example, the lower frequency of women with advanced age and less access to artificial fertilization treatment.

NICU are intended for the care of severe-condition NB or those at risk of death. Among other characteristics, the Ministry of Health considers severe-condition newborns to be less than 30 weeks of gestational age or with birth weight below 1,000 g²⁹. This parameter, with a birth weight of less than 1,000 g, seems to be a very low cutoff point, as this group of NB has a high probability of death³⁰, and the adoption of this parameter may lead to a low proportion of indication for the use of intensive care. Consequently, it was observed that there was a high number of very low birth weight NB (< 1,500 g) and many premature infants who were not in the NICU nor the NIMCU. This fact suggests difficulties in accessing these services, a hypothesis supported by the results of research on pediatric and neonatal ICUs in São Paulo, which identified an excess of neonatal beds in the private sector and a deficit of those in the public one¹⁰.

NB admitted to the NICU had more unfavorable characteristics (higher frequency of very low birth weight, very premature) than those admitted to the NIMCU and the other NB. This NB profile admitted to the NICU is similar to that obtained in other regions of the country^{3,11}.

It was observed that the NB who were not hospitalized had low neonatal mortality, which indicates that the assessment of mortality risk is present in the indication for postpartum hospitalization in the SUS network.

Neonatal mortality in the SUS birth cohort was 9.3 per thousand live births, a value 31% higher than the neonatal mortality observed that same year for all births in the city of São Paulo (7.3)³¹, which can be partly resulting from the user profile of the SUS. This result is similar to that observed in another study⁹, which points to greater availability of delivery care services and better socioeconomic conditions for pregnant women in the private network as opposed to the public one.

Neonatal mortality of NB admitted to the NICU was 2.7 times higher than among those admitted to the NIMCU and 160 times higher than those not admitted. It is expected that live births admitted to the NICU have a higher risk of neonatal death³², however the mortality in the NICU of SUS hospitals in São Paulo was higher than that recorded in Australia³³ and similar to that of the NIMCU in Mexico³⁴.

In the final model for neonatal mortality, no sociodemographic and obstetric characteristics remained as a factor associated with death after adding the most proximal variables. As the study population is exclusively SUS-dependent, it is likely that the sociodemographic variables available in the databases used were not sufficient to differentiate individuals in this universe.

As identified in this study, the inadequate number of prenatal consultations was a factor associated with neonatal mortality in other investigations⁷. The performance of prenatal care is indirect, as it is during consultations that the pregnant woman's health problems are identified and interventions are recommended to prevent pregnancy complications, which can increase the risk of neonatal mortality. Not having prenatal care may be an option for pregnant women, especially in unwanted pregnancies, and may indicate organizational barriers in health services³⁵ or difficulties in locomotion due to the distance from basic health units³⁶.

A higher risk of neonatal mortality was identified in births with multiple pregnancies, even when adjusted for the other variables. Such pregnancies are associated with intra-uterine growth retardation, prematurity, conditions that together lead to lower survival⁵. The Apgar score at 5 minutes < 7 represents the low vitality of NB and increased risk of neonatal death from SUS births, as in other investigations³⁷.

Those born not too premature (32–36 weeks) and weighing between 1,500 and 2,499 g had a higher mortality than those born at term and weighing more than 2,500 g, though not associated with neonatal mortality, which indicates that the care received during hospitalization may have contributed to their survival. Very low birth weight ($< 1,500$ g) and very premature NB³⁸ have a recognized risk of neonatal mortality, which was also identified in this study. Live births with less than 32 weeks of gestation had a 2.6-fold risk for neonatal mortality when compared to full-term births, when adjusted for the presence of the other variables.

This research was conducted with secondary data, which may contain errors in records, underreporting and limitations, such as the absence of variables that may be present in the complex causality network of NB hospitalizations and neonatal mortality. However, these limitations do not reduce the relevance of the information produced by SUS health services. As the information is analyzed and presented, the real meaning of health data records is evidenced, which can generate investments in improving the filling of basic documents for the health information systems, in addition to identifying deficiencies in services and assistance in guiding the development of intervention strategies.

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