

## A populational based study on the prevalence of neonatal *near miss* in a city located in the South of Brazil: prevalence and associated factors

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### Abstract

*Objectives:* to identify the prevalence of neonatal near miss morbidity in the city of Joinville, SC and the associated factors.

*Methods:* a populational based cross-sectional study including all live births in 2012 registered at SINASC. The near miss cases were identified based on the weight <1500g, Apgar scores at 5th minute <7, gestational age <32 weeks, use of mechanical ventilation or presence of congenital malformation. The gross odds ratios (OR) and its respective 95% confidence intervals (95% CI) were calculated and the logistic regression was performed to obtain the adjusted odds ratios and its respective 95% CI.

*Results:* the prevalence of near miss was 33 per thousand live births (95% CI: 29-37). In the final model, a risk classification of live births according to the City Program (Programa Municipal) (OR<sub>aj</sub>= 19.7; 95% CI: 14.2 to 27.2), cesarean section (OR<sub>aj</sub>= 2.1; 95% CI:1.5 to 2.8) and public hospital (OR<sub>aj</sub>= 1.7; 95% CI: 1.2 to 2.3) remained associated to morbidity near miss.

*Conclusions:* near miss morbidity was 7.3 times higher than neonatal mortality. To know its determinants in different national contexts may include some changes in the focus of public health actions by redirecting to preventive interventions.

**Key words** Child mortality, Near miss, Risk factors, Maternal and child health

## Introduction

Neonatal *near miss* morbidity is a recent concept used for events that almost led to newborn babies' death in the first 28 days of life.<sup>1-5</sup>

Studies show that the number of newborn babies who survived such morbidities affect is approximately 3 to 6 times greater than those who died.<sup>1,3,6</sup> Thus, its use is considered of great interest and may bring advantages in relation to neonatal mortality, since severe morbidities that affect newborn babies without causing death, in general, do not have visibility in the health statistics. Therefore, they are not the object of interventions in the public health context, especially regarding the quality of care in the area of maternal and child health.<sup>1,2,5,6</sup>

In low and middle income countries, the reduction of neonatal component of infant mortality has occurred in a pace below the expected.<sup>7</sup> In Brazil, between 1990 and 2013, the coefficient decrease on infant mortality rate was 76% and the neonatal and post-neonatal mortality components were, respectively, 71% and 83%.<sup>8</sup> In this context, the use of neonatal *near miss* morbidity may provide knowledge and guide decisions to managers and professionals seeking to improve their attention to newborns at risk along with consequent effects on neonatal mortality.

Due to the enormous variability of realities in the countries regarding the registration of health information and the technological advances in newborns' care, so far there was no consensus in the criteria establishment for neonatal *near miss* morbidity.<sup>1,5,6</sup>

In Brazil, morbidity has recently been studied and the diversity of the proposed criteria has impacts on its magnitude.<sup>1,5,6</sup> Using data from *Nascer no Brasil* (Born in Brazil) research, Silva *et al.*<sup>3</sup> tested 19 demographic and socioeconomic variables related to health services and selected 5 considered to be predictors of neonatal death. Based on validated criteria of Silva *et al.*<sup>3</sup> study, this study aims to identify the prevalence of neonatal *near miss* morbidity in the city of Joinville, SC and the associated factors.

## Methods

A populational based cross-sectional study, which included all women's live births residing in the city of Joinville in 2012.

The city of Joinville is considered as the third economic pole in the south region and it presents an elevated human development rate (HDR = 0.857) and in 2012 there were 526 thousand inhabitants. The basic healthcare network in 2012 was composed

of 54 units and the childbirth assistance was performed in four hospitals, of those two were public hospitals. All the hospitals in the city have neonatal ICU with a total of 32 hospital beds, a little more than half belong to the public hospitals.<sup>9</sup> The coefficient of infant mortality in the city has remained below 10 per thousand since 2001 with a predominance of neonatal component (65%).<sup>10</sup>

The maternal and live births data were obtained from the Live Births Information System (Sistema de Informações Sobre Nascidos Vivos) (SINASC), and was composed of sociodemographic variables (age, marital status, schooling, skin color and maternal work); in pregnancy (parity, type of current pregnancy, gestational age); prenatal care (basic unit model assigned to home address and prenatal initiation; relating to childbirth (type of establishment, type of delivery) and live births (gender, birth weight, Apgar score at 5<sup>th</sup> minute, presence of congenital malformation). To assess the adequacy or not the amount of prenatal consultations of gestational age, a Humanization Program for Childbirth and Birth (Programa de Humanização do Parto e Nascimento) was used to recommend at least one consultation in the first quarter, two in the second and three in the third, totaling six consultation visits. This study considered to be appropriate to conduct at least six or more consultation visits for a pregnant woman at 37 weeks or more; five consultation visits for a pregnant woman at 32 to 36 weeks; and four consultation visits a pregnant women at 22 to 32 weeks).<sup>11</sup>

The information on newborns' risk classification was obtained from the city service on epidemiological surveillance. Biological criteria (low birth weight, Apgar score at fifth minute, prematurity, malformations) and social (age, schooling and maternal marital status, number of children living and dead, absence of prenatal care) were based on and defined by the City Program for Child Healthcare (Programa Municipal de Atenção à Saúde da Criança) and it is routinely performed soon after birth.<sup>10,12</sup> All live births which used mechanical ventilation in public and private hospitals in the period of January 01, 2012 and January 31, 2013 were identified in the information systems of those hospitals. With the use of the *linkage* procedure, and using the variables: date of birth, mother's name and the hospital where the delivery took place, it was possible to locate 100% of the children in SINASC.

The studied outcome was on neonatal *near miss* morbidity of all live births in public and private hospitals. The identification of neonatal *near miss* screening cases was based on Silvia *et al.*<sup>3</sup> study,

whose criteria showed an elevated sensitivity (92.5%) and specificity (97.1%). Neonatal *near miss* cases were considered if at least one of the live births met the following criteria: gestational age less than 32 weeks, birth weight less than 1500g, the use of mechanical ventilation, Apgar score at 5<sup>th</sup> minute of life less than 7 and the presence of congenital malformations registered at SINASC. The exclusion criteria were live births that died in the first 4 weeks of life (neonatal deaths), which the data were provided by the Mortality Information System (Sistema de Informação de Mortalidade - SIM).<sup>10</sup>

The data collected were reviewed and stored in the MsExcel spreadsheet 2010. The magnitude of the effect in the explanatory variables was estimated by calculating the gross *odds ratio* (OR) and its respective 95% confidence intervals (95% CI). The OR was used as an approximation of the relative risk given by the small number of events. Subsequently, it was performed the adjusted logistic regression to obtain the adjusted *odds ratios* and its respective 95% CI. The initial model included the variables that reached significant probability (*p* value) less than 0.20 in the gross analysis. The selection of the variables in the final model was made by the non-conditional stepwise backward method.

In the final model, those variables were considered significant if they had reached *p* value of <0.05. As a measurement of quality on the adjusted final model, the Hosmer-Lemeshow test was used and had a good adjustment of the final model (*p* =0.5138). The statistical analysis was performed on the R 3.2.1 (R CORE TEAM, 2015) software with the help of the Resource Selection package.<sup>13</sup>

This study was approved by the Ethics Committee at the University in the region of

Joinville (UNIVILLE), document number 273.986.

## Results

The total number of mothers' live births residing in the city in 2012 was 7,887. After the exclusion of 35 deaths in the neonatal period, the sample number was of 7,852 live births. According to the adopted criteria, 259 were considered near miss, totaling a prevalence of 33 per thousand live births (95% CI 29-37). The neonatal mortality rate was 4.5 per thousand live births.

Among the characteristics of neonatal near miss identified, the use of mechanical ventilation had a greater proportion (48.3%) and the Apgar score at 5<sup>th</sup> minute < 7 the lowest (22.0%) (Table 1).

The prevalence of near miss morbidity observed in public hospitals (23.4 per 1,000) was significantly higher than at private hospitals (14.6 per thousand) (*p* <0.001). Table 2 presents the distribution of live births, neonatal mortality and the near miss cases according to each criterion in various locations of births (Table 2).

Regarding to the associated factors with the occurrence of neonatal near miss morbidity, the values of the gross and adjusted odds ratio (OR) showed no association to the maternal sociodemographic variables analyzed here. The greatest chance of near miss occurred among live births at risk according to the City Program for Child Healthcare (OR=19.70). Among the variables relating to pregnancy, childbirth and the care received. The cesarean section (OR=2.1) and childbirth performed in public hospitals (OR=1.7) were significantly associated to a higher chance of the outcome (Table 3).

**Table 1**

The distribution of *near miss* characteristics between newborns. Joinville, 2012 (N=7852).

<i>Near miss</i> characteristics of the newborns	N	% of the total case by case (n=7852)	CI95%	% of the total <i>near miss</i> (n=259)	CI95%
Use of mechanical ventilation	125	1.6	1.3-1.9	48.3	42.2-54.3
Gestational age <32 weeks	83	1.1	0.8-1.3	32.1	26.4-37.7
Weight < 1,500g	70	0.9	0.7-1.1	27.1	21.6-32.4
Presence of congenital malformation	59	0.8	0.6-0.9	22.8	17.7-27.9
Apgar score 5th minute < 7	57	0.8	0.5-0.9	22.0	17.0-27.1

Table 2

Distribution of the total number of live births and the near miss morbidity according to place of birth. Joinville, 2012 (N=7887).

Hospitals	Total NV		Neonatal death		Prevalence of NM (per thousand)	Near Miss Criteria*									
	n	%	n	%		Weight		Apgar		IG		VM		Malformation	
						n	%	n	%	n	%	n	%	n	%
MDV	4066	51.5	19	54.4	18.6	31	21.2	38	26.0	46	31.5	74	50.1	25	17.1
HMIJAF	444	5.6	2	5.7	4.1	5	15.6	5	15.6	6	18.7	20	62.5	13	40.6
Public HRHDS	4	0.1	2	5.7	0.1	0	-	1	100.0	0	-	1	100.0	0	-
Other city	54	0.7	0	-	0.6	2	25.0	1	12.5	1	12.5	0	-	3	37.5
HDH	1992	25.3	5	14.3	5.1	14	35.0	8	20.0	16	40.0	16	40.0	11	27.5
Private CHU	1291	16.4	5	14.3	4.1	16	50.0	4	12.5	13	40.6	14	43.7	6	18.7
Other city	21	0.2	1	2.8	0.4	2	66.7	0	-	1	33.3	0	-	1	33.3
Other location	15	0.2	1	2.8	0	0	-	0	-	0	-	0	-	0	-
Total	7887		35		33	70		57		83		125		59	

\* The percentages of the near misses criteria in each hospital exceeds 100%, because each newborn may have one or more criteria; NV=live births; IG=gestational age; VM=mechanical ventilation; MDV= Darcy Vargas Maternity; HMIJAF= Materno Infantil Jeshar Amarante Faria Hospital; HRHDS= Hans Dieter Schmidt Regional Hospital; HDH= Dona Helena Hospital; CHU= Unimed Central Hospital.

Table 3

Distribution rate of gross and adjusted *odds ratios* and the association between maternal sociodemographic characteristics and the relation to the assistance and the occurrence of *near miss*. Joinville, 2012.

Characteristics	Total of live births (N= 7852)	Neonatal <i>near miss</i> (n=259)					
		n	%	Gross OR (IC95%)	<i>p</i>	Adjusted OR (IC95%)	<i>p</i>
Sociodemographic							
Age (years)							
<19	1,060	48	4.5	1.58(1.14-2.20)	0.006	0.93(0.61-1.42)	0.746
20-34	5,809	169	2.9	1			
≥ 35	983	42	4.3	1.49(1.06-2.10)	0.024	1.01(0.66-1.55)	0.965
Marital status							
With a partner	6,312	208	3.3	1			
Without a partner	1,538	51	3.3	1.01(0.74-1.37)	0.968		
Schooling (years)							
<8	333	15	4.5	1.41(0.82-2.4)	0.210		
≥ 8	7,518	244	3.2	1			
Mother's skin color							
White	7,210	233	3.2	1			
Mixed	355	13	3.6	1.14(0.64-2.01)	0.656		
Black	212	5	2.4	0.72(0.30-1.77)	0.479		
Mother work							
Yes	4,785	133	2.8	0.67(0.52-0.86)	0.001	1.05(0.75-1.48)	0.765
No	3,067	126	4.1	1			
Relating to the pregnant woman							
Parity							
Nulliparous	3,501	114	3.3	1			
Multiparous	4,348	145	3.3	1.02(0.80-1.32)	0.846		
Type of pregnancy							
One	7,777	254	3.3	1			
Twins	75	5	6.7	2.12(0.85-5.29)	0.109	0.61(0.23-1.59)	0.309
Relating to assistance							
Assigned basic unit							
ESF*	3,087	110	3.6	1			
No ESF	4,691	141	3.0	0.84(0.65-1.08)	0.174	0.96(0.71-1.29)	0.770
Month of prenatal care initiation							
1 - 3	5,807	162	2.8				
≥ 4	1,228	43	3.5	1.26(0.89-1.76)	0.179	0.99(0.65-1.49)	0.946
Prenatal adequate queries							
Yes	6,711	206	3.1	1			
No	1,135	52	4.6	1.52(1.11-2.07)	0.009	0.95(0.60-1.52)	0.842
Risk Program**							
Yes	1,095	189	17.3	22.28 (16,58-29.93)	<0.001	19.70 (14.20-27.19)	<0.001
No	6,683	62	0.9	1			
Type of delivery							
Vaginal	3,490	88	2.5	1			
Cesarean section	4,362	171	3.9	1.58(1,21-2,05)	<0.001	2.06(1.53-2.76)	<0.001
Type of establishment							
Private	3,307	75	2.3	1			
Public	4,545	184	4.0	1.82 (1.38 to 2.39)	<0.001	1.68(1.18-2.41)	<0.004

Source: SINASC, Joinville Hospitals, January to December, 2012: Joinville, Brazil (2012).

\* ESF= Family Health Strategy; \*\*Program = City Program on Child healthcare.

The differences in the total should be absent due to the lack of information from SINASC.

## Discussion

This study identified a rate of neonatal near miss morbidity of 33.0 per thousand live births, about seven times more than the neonatal mortality rate in the same location and year, 4.5 per thousand live births. The use of the data from SINASC, with a coverage close to 100%, verified the populational based to the study, making this finding relevant to monitor the risk of infant death, especially the neonatal, currently responsible for about two-thirds of the infant deaths each year in the analyzed city.<sup>10</sup>

Until the moment, there is no international consensus to define neonatal near miss morbidity and the comparison between countries or regions in the same country is limited. The criteria adopted here were recommended by Silva *et al.*,<sup>3</sup> and based on the data from 2012 in Nascer no Brasil (Born in Brazil) research and, as they are validated, objective and have standardized registration, it was made possible to rely and evaluate the occurrence of this severe neonatal morbidity. However, the lack of integration between the data from the official information systems and the registration on the clinical records during the newborn's hospitalization, constituted some difficulties to identify the neonatal near miss in our country.<sup>14</sup> In this regard, initiatives from the Ministry of Health seeking to unify the computerized systems of public and private hospitals and integrate them to the national data of SINASC and SIM foundations, which currently have good coverage in the vast majority of the Brazilian cities, this could be a major breakthrough for the populational based studies and it would locate comparable profiles on neonatal morbimortality.

The variations in the prevalence of neonatal *near miss* morbidity observed in several studies are due to the methodological differences, either in the clinical criteria adopted to define near miss, as in the neonatal period considered to be exclusion due to deaths, which ranged from 3 to 28 days of birth.<sup>4</sup> A study conducted in South Africa with more than 3 thousand live births found a rate of *near miss* of 24.7 and a neonatal mortality rate of 6.3 per thousand live births.<sup>6</sup> In Brazil, a study using data from WHO Global Survey on Maternal and Perinatal Health 2005 based on the definition of *near miss* as the leading causes of death which are prematurity and perinatal asphyxia, found a near miss rate of 21.4 and early neonatal mortality of 8.2 per thousand.<sup>2</sup> Other authors have used the same data and included information on the handling of severe neonatal morbidity, verifying the near miss rate of 72.5 and early neonatal mortality of 8.5 per thousand.<sup>15</sup> In

Recife, a study was performed on over 24,000 live births in 2012 and constituted a near miss rate of 86.5 and early neonatal mortality of 19 per thousand.<sup>16</sup> In these studies, the neonatal near miss morbidity rate was higher than the of neonatal mortality rate between 2.6 and 8.6 times.<sup>4</sup>

Our study used the same criteria from Silva *et al.*,<sup>3</sup> where the neonatal near miss morbidity and neonatal mortality rates were higher, respectively, 39.2 and 11.1 per thousand live births. Since this deals with a national cohort on hospital database that included 266 hospitals in all the Brazilian regions with more than 24 thousand live births, the differences in the demographic and socioeconomic characteristics of the pregnant women, as well as the diversity in the healthcare organization, contrasting with the reality in the city of Joinville, located in one of the most developed regions in the country, with good social indicators and health and an organized healthcare network.<sup>9</sup>

The index that corroborates this effect is the number of risk criteria for near miss by live birth that in our study was 1.52 (394/259) and in Silva *et al.*,<sup>3</sup> study was 1.85 (1,745/943), showing in our case by case a lower concentration of risk criteria for live births.

In this present study, the mechanical ventilation was the most frequent criteria among the near miss cases (48.3%), followed by gestational age (32.1%) and low birth weight (27.1%), findings similar to Silva *et al.*<sup>3</sup>

The proportion of congenital malformation (22.8%) identified here was higher than in Silva *et al.*<sup>3</sup> study. Although it is reported as inaccuracy in the registration, those considered severe tend to be registered in greater frequency and appear to be the important cause of neonatal death, especially in more developed regions, in which the avoidable deaths have already been controlled.<sup>17,18</sup> Moreover, in Joinville, it is possible to have better registration of this information, due to routinely audits in the SINASC databank and the educational actions carried out annually by the city service on epidemiological surveillance.

This study did not find any association among demographic, socioeconomic or maternal obstetric history with neonatal near miss morbidity. In the multivariate model, after adjusting all the studied variables, those who had increased the chance of neonatal near miss were the newborns' born in a public hospital and of a cesarean section, according to the City Program on Child health.

A study conducted in Recife, 16 in eight referral hospitals showed that about 90% of the neonatal

*near miss* cases occurred in public hospitals and drew attention to the association between severe birth conditions and low economic classes. In these hospitals, there were a higher risk of *near miss* among teenage mothers, multiparous women and a lower number of prenatal consultation visits. In private hospitals, in other hand, the highest risk was associated to the cesarean section and pregnancy of twins.

In our study, the live births of cesarean section had twice the chance of near miss. Despite the higher rates of delivery via cesarean section have occurred in private hospitals (81%), the greater chance of near miss occurred in public hospitals (OR = 1.7). It is possible that the occurrence of maternal-fetal complications which would lead to clinical indication of cesarean section could in fact be the responsible for negative neonatal events and not by delivery itself. To elucidate this point, it would be necessary to investigate whether the indication of cesarean deliveries was intrapartum, due to maternal-fetal complications, or it was elective without any clinical basis. There are evidences of association between iatrogenic cesareans and maternal outcomes and negative neonatal effects, such as prematurity, neonatal respiratory morbidity, ICU hospitalization, the use of mechanical ventilation and maternal near miss.<sup>3,16,17,19,20,21</sup> Therefore, the advantages of women with better socioeconomic conditions that mostly are attended at private hospitals could be mitigated by elective indication for a cesarean section.<sup>21</sup> In our study, the main public hospital is a referral service in the city and regional for high risk deliveries and, thus, receives patients screened at risk. However, it was not possible to study the association between maternal-fetal complications and near miss due to the chosen study design and the data sources used such as SINASC and SIM which led to some lack of information.

The medical literature shows that the determinants of neonatal mortality and near miss morbidity are very similar and understands that the socioeconomic characteristics,<sup>17,18,22-25</sup> low schooling level and the maternal marital status,<sup>17,20</sup> bad obstetric history,<sup>18,25</sup> lack of access and quality in prenatal<sup>17,18,22,26</sup> twin and premature pregnancy.<sup>18,25,27</sup>

Our results show that the variable that most likely associated to neonatal near miss morbidity was the classification of risk to live births according to the Program for Child Health ( Programa de Saúde da Criança) in the city. This finding may be plausible since the risk criteria adopted by the program under-

stand the factors already established for infant morbimortality, especially neonatal.<sup>12</sup> Thus, the risk found was 19 times for near miss seems to confer robustness to the discriminatory capacity of classifying the risk in the program to identify vulnerability of live births.

There were no identification on the association between near misses and prenatal care. Unlike other studies that have analyzed associated factors to neonatal mortality<sup>26-28</sup> in this city, a late onset on prenatal care and the number of prenatal consultation visits did not increase the chance for *near miss*.<sup>11,17</sup> These controversies indicate gaps in knowledge about the participation to access prenatal care, the quantity and quality of consultations in the determination of negative outcomes for the mother and the newborn, in socioeconomic contexts with great disparities, such as in the case in Brazil. In Joinville, the interaction between well structured public policies, job opportunities and elevated economic development provide favorable conditions for the reduction of social inequalities and, thus, could minimize the negative effects of low social integration in health.<sup>9</sup> A study conducted in the city of Blumenau (SC), with socioeconomic characteristics similar to those of the city studied here, strengthens this hypothesis.<sup>29</sup>

The main limitation of this study refers to the use of the secondary database (SINASC), due to the lack of standardized registration and the lack of some relevant data for epidemiological studies on maternal and child health, as mentioned by other authors.<sup>30</sup> In this study, the absence of interest variables for risk identification, as the moment of indicating a cesarean section (intrapartum vs. elective) and the variables related to maternal complications during the pregnancy or in labor made it impossible to elucidate its relation to the type of delivery via cesarean section, the type of hospital and the occurrence of near miss, since the public hospitals provide care for women in the worst social conditions and at greater obstetric risk. Consequently, the worst results observed in these hospitals may be due to the higher prevalence of complications in pregnant women attended at these services.

The neonatal near miss morbidity constitutes of a promising tool and very useful to monitor and prevent the 'near death' in the neonatal period, allowing the quality evaluation in handling newborn babies with complications and subsidize the adequate planning for resources and priorities to aim at improving the quality of care for pregnant women, parturients and newborns. Knowing the determinants

in different national contexts can provide a change in the focus of public health actions, redirecting

them to preventive interventions.

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