Perinatal asphyxia associated with early neonatal mortality: populational study of avoidable deaths

Asfixia perinatal associada à mortalidade neonatal precoce: estudo populacional dos óbitos evitáveis

Asfixia perinatal asociada a la mortalidad neonatal temprana: estudio de población de los óbitos evitables

Mandira Daripa[1], Helena Maria G. Caldas[2], Luis Patricio O. Flores[3], Bernadette Cunha Waldvogel[4], Ruth Guinsburg[5], Maria Fernanda B. de Almeida[6]

ABSTRACT

Objective: To compare the epidemiological profile of avoidable early neonatal deaths associated with perinatal asphyxia according to region of death in the State of São Paulo, Brazil.

Methods: Population-based cohort study including 2,873 avoidable deaths up to six days of life associated with perinatal asphyxia from January 2001 to December 2003. Perinatal asphyxia was considered if intrauterine hypoxia, birth asphyxia, or meconium aspiration syndrome were written in any line of the original Death Certificate. Epidemiological data were also extracted from the Birth Certificate.

Results: During the three years, 1.71 deaths per 1,000 live births were associated with perinatal asphyxia, which corresponded to 22% of the early neonatal deaths. From the 2,873 avoidable deaths, 761 (27%) occurred in São Paulo city; 640 (22%), in the metropolitan region of São Paulo city; and 1,472 (51%), in the countryside of the state. In the first two regions, deaths were more frequent in public hospitals, among newborns with gestational age of 36 weeks or less, and among babies weighing less than 2500g. In the countryside, mortality was more frequent in philanthropic hospitals, in term newborns and in neonates weighing over 2500g. Most of these neonates were born during daytime in their hometown and died at the same institution in which they were born within the first 24 hours after delivery. Meconium aspiration syndrome was related to 18% of the deaths.

Conclusions: Perinatal asphyxia is a frequent contributor to the avoidable early neonatal death in the state with the highest gross domestic product *per capita* in Brazil, and it shows the need for specific interventions with regionalized focus during labor and birth care.

Key-words: infant, newborn; asphyxia neonatorum; early neonatal mortality; meconium aspiration syndrome.

RESUMO

Objetivo: Comparar o perfil epidemiológico dos óbitos neonatais precoces evitáveis associados à asfixia perinatal conforme a região de ocorrência do óbito no Estado de São Paulo.

Métodos: Coorte populacional constituída por 2.873 óbitos evitáveis até seis dias de vida associados à asfixia perinatal ocorridos entre janeiro de 2001 e dezembro de 2003. Considerou-se como asfixia perinatal a presença de hipóxia intraútero, asfixia ao nascer ou síndrome de aspiração de mecônio em qualquer linha da Declaração de Óbito original. Variáveis epidemiológicas também foram extraídas das Declarações de Nascido Vivo.

Resultados: No triênio, 1,71 mortes por 1.000 nascidos vivos estavam associadas à asfixia perinatal, correspondendo a 22% dos óbitos neonatais precoces. Dos 2.873 óbitos

Instituição: Escola Paulista de Medicina (EPM), Universidade Federal de São Paulo (Unifesp), Fundação Sistema Estadual de Análise de Dados (Fundação SEADE), São Paulo, SP, Brasil

[1]Mestre em Pediatria pela EPM, Unifesp; Médica Assistente da Disciplina de Pediatria Neonatal da EPM, Unifesp, São Paulo, SP, Brasil

[2]Médica Colaboradora da Disciplina de Pediatria Neonatal da EPM, Unifesp, São Paulo, SP, Brasil

[3]Doutor em Saúde Pública pela Universidade de São Paulo (USP); Chefe da Divisão de Produção de Indicadores Demográficos da Fundação SEADE, São Paulo, SP, Brasil

[4]Doutora em Saúde Pública pela USP; Gerente de Indicadores e Estudos Populacionais da Fundação SEADE, São Paulo, SP, Brasil

[5]Livre-Docente em Pediatria pela EPM, Unifesp; Professora Titular da Disciplina de Pediatria Neonatal da EPM, Unifesp, São Paulo, SP, Brasil

[6]Doutora em Pediatria pela EPM, Unifesp; Professora-Associada da Disciplina de Pediatria Neonatal da EPM, Unifesp, São Paulo, SP, Brasil

Endereço para correspondência:
Mandira Daripa
Rua Nossa Senhora do Sion, 205
CEP 12941-480 – Atibaia/SP
E-mail: daripa@hotmail.com

Conflito de interesse: nada a declarar

Recebido em: 6/6/2012
Aprovado em: 10/9/2012

evitáveis, 761 (27%) ocorreram em São Paulo, capital; 640 (22%), na região metropolitana da capital; e 1.472 (51%), no interior do estado. Nas duas primeiras regiões predominaram as mortes em hospitais públicos, recém-nascidos com idade gestacional inferior a 37 semanas e peso abaixo de 2500g. No interior, os óbitos foram mais frequentes em entidades beneficentes, recém-nascidos a termo e com peso superior a 2500g. A maioria dos bebês nasceu durante o dia no município de residência materna e evoluiu para óbito no hospital de nascimento até 24 horas após o parto. A síndrome de aspiração de mecônio esteve presente em 18% dos óbitos.

Conclusões: A asfixia perinatal é um contribuinte frequente para a morte neonatal precoce evitável no estado com o maior produto interno bruto *per capita* do Brasil, evidenciando a necessidade de intervenções específicas com enfoque regionalizado na assistência ao parto e ao nascimento.

Palavras-chave: recém-nascido; asfixia neonatal; mortalidade neonatal precoce; síndrome de aspiração de mecônio.

RESUMEN

Objetivo: Comparar el perfil epidemiológico de los óbitos neonatales tempranos evitables asociados a la asfixia perinatal conforme a la región de ocurrencia del óbito en la provincia de São Paulo (Brasil).

Métodos: Cohorte de población constituida por 2.873 óbitos evitables hasta seis días de vida asociados a la asfixia perinatal ocurridos entre enero de 2001 y diciembre de 2003. Se consideró como asfixia perinatal la presencia de hipoxia intraútero, asfixia al nacer o síndrome de aspiración de meconio en cualquier línea de la Declaración de Óbito original. Variables epidemiológicas también fueron extraídas de las Declaraciones de Nacido Vivo.

Resultados: En el trienio, 1,71 muertes por 1.000 nacidos vivos estaban asociadas a la asfixia perinatal, correspondiendo al 22% de los óbitos neonatales tempranos. De los 2.873 óbitos evitables, 761 (27%) tuvieron lugar en São Paulo, capital; 640 (22%), en la región metropolitana de la capital; y 1.472 (51%) en el interior de la provincia. En las dos primeras regiones predominaron las muertes en hospitales públicos, recién nacidos con edad gestacional inferior a 37 semanas y peso inferior a 2.500g. En el interior, los óbitos fueron más frecuentes en entidades benéficas, recién nacidos a término y con peso superior a 2.500g. La mayoría de los bebés nació durante el día en el municipio de residencia materna y evolucionó a óbito en el hospital de nacimiento hasta 24 horas después del parto. El síndrome de aspiración de meconio estuvo presente en el 18% de los óbitos.

Conclusiones: La asfixia perinatal es un contribuyente frecuente a la muerte neonatal temprana evitable en la provincia con el más grande producto interno bruto *per capita* de Brasil, lo que evidencia la necesidad de intervenciones específicas con enfoque regionalizado en la asistencia al parto y al nacimiento.

Palabras clave: recién nacido; asfixia neonatal; mortalidad neonatal temprana; síndrome de aspiración de meconio.

Introduction

There is a global commitment to reduce mortality of children under 5 years old by two-thirds up to 2015, and Brazil is one of the signatory countries of the "Millennium Development Goals". Worldwide, these deaths predominate in the neonatal period with emphasis on three causes: prematurity, perinatal asphyxia, and neonatal infections[1].

Perinatal asphyxia, due to lack of adequate fetal-neonatal oxygenation in peripartum, at birth, and in the first minutes of life, is a sensitive measure of the quality of care provided in the perinatal period, both to the pregnant woman and the newborn, with high potential for prevention of death through early diagnosis and treatment[2]. In Brazil, isolated centers emphasize perinatal asphyxia as a major cause of early neonatal mortality, with variation in incidence according to the criteria used[3,4]. However, for the planning of the public policies that can effectively reduce neonatal mortality by asphyxiation, it is important to know the epidemiological profile of these casualties in the population and regional levels.

The state of São Paulo corresponds to the most populous unity in Brazil, with the largest gross domestic product (GDP) per capita in the country. In South America, the state of São Paulo is the third most populous political unit, in addition to holding the second highest GDP per capita and the third highest level of human development index (HDI) in Brazil[5]. With about 40 million inhabitants and 600,000 births per year, it consists of the capital city (São Paulo), the metropolitan area of the capital (38 municipalities) and the countryside (606 municipalities). The first two occupy 3.2% of the state territory and stand out for the concentration of nearly half the population. Despite regional socioeconomic differences, birth rates (16.13 by 1,000 inhabitants) and early neonatal mortality rates (7.28 by 1,000 live births) are similar in all three locations[6].

In this perspective, the current investigation described the rate of early neonatal deaths associated with perinatal asphyxia and compared the demographic, maternal and neonatal characteristics of such casualties according to the regions of the state of São Paulo, in the period from 2001 to 2003.

Method

This research was conducted in a population cohort with casualties associated with perinatal asphyxia that occurred before 168 hours of life between January 1st, 2001 and December 31st, 2003 in the capital, in the metropolitan region of the capital, and in the countryside of the state of São Paulo.

Deaths associated to the presence of perinatal asphyxia were identified by diagnosis of cause of death, according to the International Classification of Diseases (ICD) 10, registered in any line (Ia, Ib, Ic, Id or II) of the Death Certificate (DC), such as: P20.0 – intrauterine hypoxia diagnosed before the onset of labor; P20.1 – intrauterine hypoxia diagnosed during labor and delivery; P20.9 – unspecified intrauterine hypoxia; P21.0 – severe birth asphyxia; P21.1 – mild or moderate asphyxia at birth; P21.9 – unspecified birth asphyxia; and P24.0 – neonatal meconium aspiration[7].

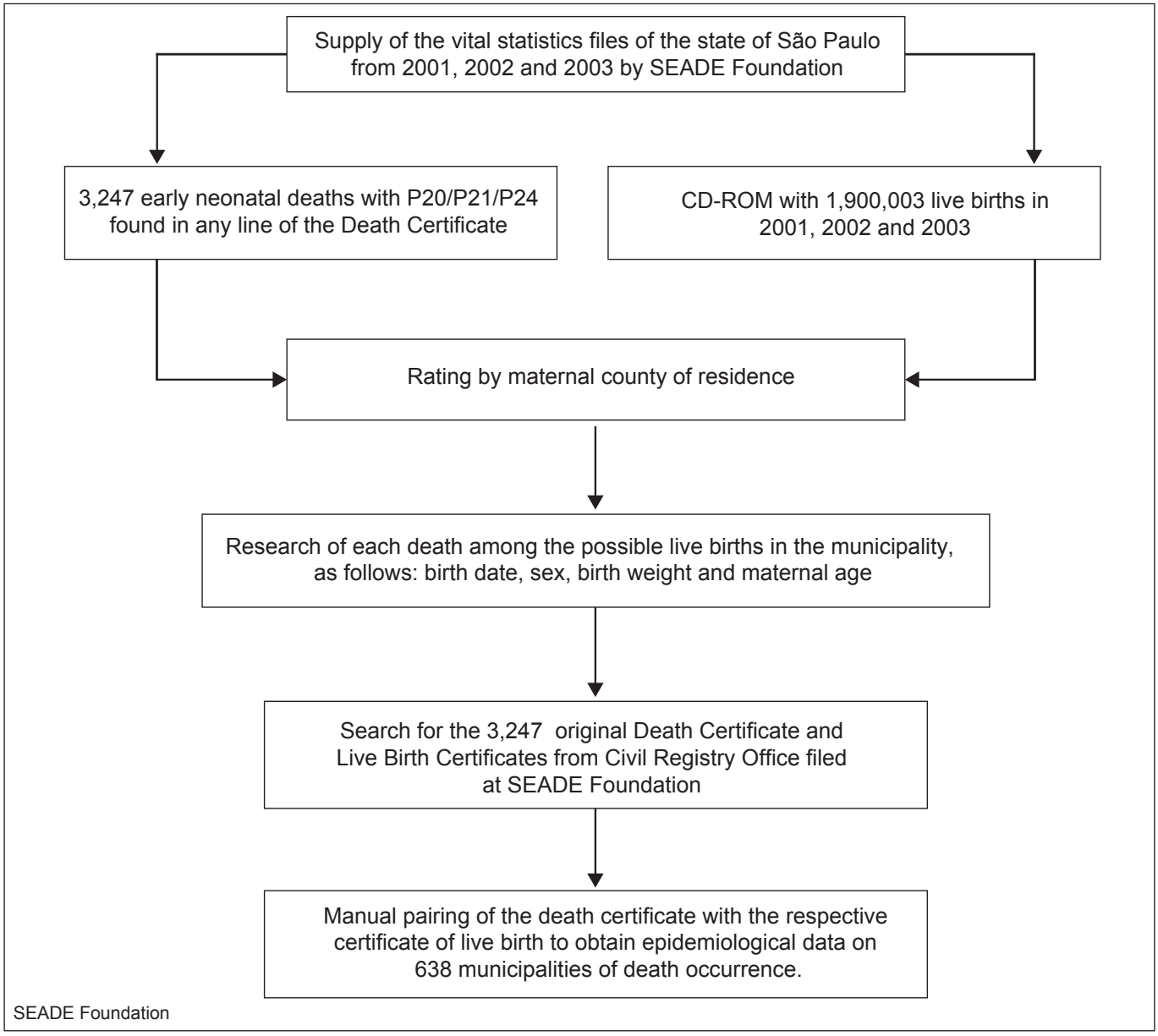

Figure 1 - Study design

Unavoidable deaths were excluded, namely: gestational age less than 22 weeks[8], birthweight below 400g[9], or congenital anomaly incompatible with life[2]. Additionally, the causes of death classified as P24.1 (aspiration of neonatal fluid and mucus), P24.2 (neonatal aspiration of blood), P24.9 (unspecified neonatal syndrome) and P91.4 (neonatal cerebral depression) were excluded from the study as well as those occurring in the first week of 2004 with birth in 2003.

The study design is in Figure 1, and the epidemiologic data comprised demographic, maternal, and neonatal characteristics marked in DCs and in the respective Live Birth Certificate (CLB). Demographic characteristics were related to the occurrence of birth in the municipality of maternal residency, the classification of the place of birth and death, period of daytime birth (7 and 19 hours) and to the occurrence of death in the same place of birth. Maternal data analyzed included age, marital status, education, occupation, parity, number of antenatal visits, type of pregnancy, childbirth, and maternal and perinatal conditions (P00 to P04 and P70 from CID – 10). The neonatal characteristics described were: gestational age, weight, sex, race/ethnicity, Apgar score at first and fifth minutes, survival time, presence of syndrome of meconium aspiration and congenital malformation compatible with life.

Initially, we calculated the frequency of early neonatal deaths associated with perinatal asphyxia detected in this study in relation to the number of live births and early neonatal deaths obtained in the Data Analysis State System Foundation – SEADE Foundation (Fundação Sistema Estadual de Análise de Dados - Fundação SEADE)[6], during the triennium 2001-2003 in the capital, the metropolitan area of São Paulo city, and in the countryside of the state of São Paulo.

For each variable, the number of valid observations in the triennium was determined. Categorical and numerical variables have been described in frequency, considering the number found in relation to valid observations. The comparison of epidemiologic data compiled from early neonatal

Table 1 - Number of births, deaths and early neonatal deaths associated with early neonatal perinatal asphyxia, according to regions of the state of São Paulo, 2001 to 2003

	Total	Region of the state of São Paulo		
		Capital	Metropolitan São Paulo	Countryside
Live births*	1,900,003	559,690	433,294	907,019
Deaths from zero to 6 days*	14,597	3,926	3,361	7,310
Early neonatal deaths associated to asphyxia	3,247	898	713	1,636
Early neonatal mortality associated to asphyxia every 1.000 live births	1.71	1.60	1.65	1.80
Mortality associated to asphyxia in relation to early neonatal deaths (%)	22	23	21	22

*SEADE Foundation[8]

Table 2 - Frequency* of the demographic variables of 2,873 early neonatal avoidable deaths associated to perinatal asphyxia, according to the region of occurrence of death in the state of São Paulo, 2001 to 2003

	Region of the state of São Paulo			*p*-value
	Capital (n=761)	Metropolitan São Paulo (n=640)	Country (n=1,472)	
Born in the city of maternal residence	688 (91%)	469 (74%)	1,060 (74%)	<0.001
Hospital of birth				<0.001
Philanthropic hospitals	162 (22%)	141 (23%)	759 (61%)	
State	221 (30%)	116 (19%)	129 (10%)	
Municipal	170 (23%)	174 (28%)	166 (14%)	
Private	146 (20%)	140 (23%)	151 (12%)	
Other	45 (6%)	44 (7%)	37 (3%)	
Born in daytime	452 (60%)	315 (51%)	830 (60%)	<0.001
Death at the birth institution	701 (97%)	577 (95%)	1,020 (84%)	<0.001

*Frequency corresponds to the number observed in the number of valid observations for each variable

deaths associated to perinatal asphyxia in the three regions was performed using the chi-square or Fisher, considering level of significance less than 0.05.

The research project was approved by the Research Ethics Committee of Universidade Federal de São Paulo (0357/03) after agreement of scientific-technical cooperation with SEADE Foundation.

Results

Table 1 shows the number of live births and early neonatal deaths in the state of São Paulo during the triennium 2001-2003, according to the region of death occurrence Among the 14,597 early neonatal deaths, 3,247 (22%) were associated to perinatal asphyxia, being 11.5% due to unavoidable causes (95 cases with gestational age <22 weeks or birth weight <400g and 279 deaths by congenital anomaly incompatible with life). Thus, the study included the epidemiological profile of 2,873 avoidable early neonatal deaths associated to perinatal asphyxia.

The acquisition of the 23 variables including demographic, maternal, and neonatal characteristics was possible in almost all the cases. Two of them (maternal municipality of residence and sex) showed 100% of valid observations, 14 had between 96 to 99% of the information, and three, from 91 to 95% (site of occurrence of birth, marital status, and education). The four variables with 85 to 90% completion were parity (87%), antenatal visits (89%) and Apgar scores in the first (89%) and in the fifth minute (89%).

Among the 2,873 avoidable deaths, 761 (27%) occurred in the capital; 640 (22%), in the metropolitan region of the capital; and 1,472 (51%), in the countryside. Great part of births took place in the same municipality of maternal residence and during morning and afternoon. In the capital and metropolitan area of the capital, delivery was more common in state and local public institutions, followed by philanthropic hospitals. In the countryside of the state, most births occur in philanthropic hospitals (Table 2).

In most cases, mothers were young, aged between 20 and 34 years, had a steady partner, did not work, and almost

Table 3 - Frequency* of maternal variances of the 2,873 avoidable early neonatal deaths associated to perinatal asphyxia, according to the region of occurrence of death in the state of São Paulo, 2001 to 2003

Maternal characteristics	Region of the state of São Paulo			*p*-value
	Capital (n=761)	Metropolitan São Paulo (n=640)	Countryside (n=1,472)	
Age (years)				0.004
10 to 19	134 (18%)	155 (24%)	332 (23%)	
20 to 34	504 (67%)	398 (63%)	935 (65%)	
35 or more	118 (15%)	84 (13%)	168 (12%)	
Married/Stable Union	348 (48%)	353 (57%)	863 (64%)	<0.001
Education (years)				<0.001
3 or less	80 (12%)	128 (20%)	242 (17%)	
4 to 7	229 (33%)	227 (36%)	502 (37%)	
8 to 11	283 (40%)	222 (35%)	491 (36%)	
12 or more	108 (15%)	53 (9%)	135 (10%)	
Housewife	478 (65%)	498 (79%)	1.038 (74%)	<0.001
Parity				<0.001
Primiparous	394 (61%)	327 (54%)	445 (35%)	
Secundiparous	112 (17%)	123 (21%)	363 (29%)	
≥Terciparous	141 (22%)	152 (25%)	447 (36%)	
Antenatal visits				<0.001
3 or less	240 (36%)	194 (33%)	312 (24%)	
4 to 6	223 (34%)	219 (37%)	451 (34%)	
7 or more	199 (30%)	183 (30%)	544 (42%)	
Multiple pregnancy	80 (11%)	50 (8%)	109 (7%)	0.033
Vaginal delivery	415 (55%)	362 (57%)	775 (53%)	0.330
Clinical/ obstetric disorders	131 (17%)	114 (18%)	238 (16%)	0.610

*Frequency corresponds to the number observed regarding the number of valid observations for each variable

half of them studied for 8 years or more. Most mothers in the capital were primiparous and in their second or further delivery in the countryside, attended at least four antenatal visits, with the predominance of single pregnancy and resolution of delivery via vaginal route (Table 3).

Neonatal characteristics revealed that while in the capital and in the metropolitan area of the capital most of the babies were premature and weighed less than 2,500g, in the countryside stood out those term and post-term and with more than 2,500g. Regarding gender and race, just over half were male and 80% were white. The survival time of those newborns was noteworthy: most of them died before completing the first 24 hours of life. The indexes between zero and six on the Apgar scores were noted in 91% of patients in the first minute and in 71% of cases, in the fifth minute (Table 4).

Discussion

The present population study revealed that perinatal asphyxia contributed to the death of 1.71 newborns per 1,000 live births and 22% of early neonatal deaths in São Paulo State from 2001 to 2003. In the capital and in the metropolitan area of the state capital predominated avoidable deaths in infants with gestational age less than 37 weeks and birth weight below 2,500g, in public hospitals. In the countryside, deaths occurred more frequently in term newborn infants weighing more than 2,500g, in philanthropic hospitals.

This value is similar to the national neonatal mortality rate of 1-2 by 1,000 live births observed in developed countries such as Finland, France, Japan, Norway, Sweden and Singapore in 2004[10]. However, perinatal asphyxia in 22% of early neonatal deaths is 3 times higher than the

Table 4 - Frequency* of variables of neonates from 2,873 early avoidable deaths associated to perinatal asphyxia, according to the region of occurrence of death in the state of São Paulo, from 2001 to 2003

Neonatal characteristics	Region of the state of São Paulo			*p*-value
	Capital (n=761)	Metropolitan São Paulo (n=640)	Countryside (n=1,472)	
Male Sex	405 (53%)	345 (54%)	834 (57%)	0.219
Race/color				<0.001
White	549 (76%)	492 (80%)	1,185 (82%)	
Brown	153 (21%)	106 (17%)	207 (14%)	
Other	23 (3%)	17 (3%)	4%)	
Gestational age (weeks)				<0.001
22 to 27	255 (35%)	161 (25%)	301 (21%)	
28 to 31	152 (20%)	109 (17%)	170 (12%)	
32 to 36	114 (15%)	131 (21%)	248 (18%)	
37 or more	218 (30%)	232 (37%)	695 (49%)	
Birth Weight				<0.001
400 to 1499g	415 (55%)	272 (43%)	505 (35%)	
1500 to 2499g	126 (17%)	135 (21%)	277 (19%)	
2500g or more	210 (28%)	231 (36%)	656 (46%)	
Apgar at the 1st minute				0.240
0 to 3	508 (72%)	387 (67%)	880 (70%)	
4 to 6	132 (19%)	130 (22%)	269 (21%)	
Apgar are the 5th minute				<0.001
0 to 3	241 (34%)	189 (32%)	530 (42%)	
4 to 6	232 (33%)	198 (34%)	400 (32%)	
Survival				0.002
<60 minutes	83 (11%)	95 (16%)	233 (16%)	
1 to 23 hours	340 (47%)	305 (50%)	706 (49%)	
24 to 71 hours	190 (26%)	127 (21%)	355 (24%)	
Syndrome of meconium aspiration	94 (12%)	110 (17%)	320 (22%)	<0.001
Congenital anomaly compatible with life	52 (7%)	50 (8%)	120 (8%)	0.530

*Frequency corresponds to the number observed in the number of valid observations for each variable

rate of 8.2%, regarding the period of 2001 to 2003 in the state of São Paulo, released by SEADE Foundation [6] and by the Department of Informatics of the Brazilian Unified Health System (Departamento de Informática do Sistema Único de Saúde - DATASUS)[11]. This discrepancy stems from the fact that these institutions consider intrauterine hypoxia and asphyxia at birth as an underlying cause, which is defined as a disease that starts a chain of morbid events leading directly to death, according to recommendations of the World Health Organization (WHO) for comparison between geographical areas and the year. Additionally, the vital statistics take into consideration the presence of maternal morbidities or prematurity as the underlying cause of early neonatal death, even when hypoxia and/or perinatal asphyxia are reported on the Death Certificate, which may underestimate this entity as a contributor for this outcome[7].

Current research also included meconium aspiration syndrome, because it is directly connected to the chain of events associated with perinatal asphyxia[12], highlighting that this entity is classified as other respiratory conditions of the newborn as basic cause of death by the WHO[7]. Responsible for 10% of cases of respiratory failure[13], aspiration of meconium caused the death of practically one baby in every five early neonatal avoidable deaths in the state of São Paulo, stressing the high mortality rate in emerging countries such as in China, where the syndrome was responsible for 39% of deaths from respiratory failure in the early neonatal period [14].

One of the strengths of the study refers to the design which allowed the extraction of the highest number of valid observations of 23 variables due to manual binding of the original DCs with the respective Live Birth Certificate. Data from DATASUS reveals that the type of delivery, birth weight, and gestational age has 27% of information ignored when based only on DCs[11]. However, in this study, the absence of the 'number of antenatal visits', 'parity' and 'Apgar scores in the first and fifth minutes', respectively, in 11, 13 and 11% of LBCs, may reveal the ignorance about the importance of its documentation by the health professional. The lack of information regarding the variable 'Apgar score' can also be related to poor birth conditions or lack of entry caused by the absence of a doctor to receive the newborn in the delivery room, since 99% of births occur in healthcare facilities in the state São Paulo, and only 2.2% of live births have the Apgar score at five minutes ignored[11].

This investigation focused on early neonatal avoidable deaths, since patients with gestational age below 22 weeks[8], birth weight less than 400g[9] or with congenital anomalies incompatible with life[2] were excluded, allowing to determine the profile of those who had the opportunity of obstetric and/or neonatal intervention and that rarely or never should evolve to death. Among the 2,873 avoidable deaths in the triennium, 90% occurred in the same place of birth, whether in public hospitals in the metropolitan area, including the capital, or in the philanthropic hospitals in the countryside of the State. According to research by the Regional Council of Medicine of São Paulo, hospitals belonging to the Unified Health System (SUS) presented deficient infrastructure, such as lack of beds for pregnant women and for the newborn, lack of Neonatal Intensive Care Units (NICU), shortages of equipment and human resources, among others[15]. This was also observed in public hospitals, more than in the private healthcare institutions in the city of Belo Horizonte, in the state of Minas Gerais[16].

The birth of 79% of newborns who progressed to death in the same municipality of maternal residency may reflect the universal health policy of decentralization in the country. On the other hand, this finding may be overestimated, since there is the possibility that mothers provide wrong addresses only to be treated in a unity of reference of high-risk pregnancies in another municipality, after pilgrimage in various health centers without conditions of delivery assistance[17,18].

This research showed that most mothers belonged to the age group of 20 to 34 years, considered at low risk for complications during pregnancy and childbirth, and although 71% have attended more than four visits during pregnancy, the quality of antenatal care could be compromised. Brazilian studies show such inadequacy due to the great demand of pregnant women in relation to the availability of doctors, the substitution for clinical imaging, interpretation of laboratory exams by professionals who are not specialists, and to the lack of equipment and medications to perform simple treatments, culminating in high rates of maternal and neonatal mortality[17,19].

The frequency of maternal and perinatal conditions identified in this study, less than 20%, may be related to the mentioned maternal profile, of low risk, or to the underreporting in the DC[20], due to the lack of clinical habit of associating early neonatal death to a maternal cause, that triggers perinatal complications as asphyxia,

contributing to neonatal mortality in 10 to 20% of cases if not controlled properly and in a timely manner[21].

The occurrence of most births (55%) via vaginal delivery among the avoidable neonatal deaths associated to neonatal asphyxia may denote gaps in monitoring labor and delivery[22]. Like most births occurred in the same municipality of maternal residence, probably the mother in labor faced no lack of vacancies in health services. However, the time between arrival at the hospital, medical care, and birth may have been insufficient for the proper planning of birth, culminating in vaginal delivery[17,19]. The identification of abnormalities during labor leads to the need for interventions before complications occur, which can reduce deaths by asphyxia in 30 to 45% and, in emergency situations, lead to the reduction of 20 to 60% of these deaths[21].

A significant fraction of term infants weighing more than 2,500g with perinatal asphyxia, intrauterine hypoxia or meconium aspiration syndrome, as contributors to death in the first week of life, demonstrates the fragility of perinatal care in the state of higher socio-economic development in Brazil. Moreover, investment in health care varies according to the distribution of wealth in each area of the state, with the concentration of the main centers of industrial activity and services in the capital and in the metropolitan area of the capital. These facts explain the regional differences found in rates of deaths in relation to births and early neonatal deaths[8].

The amount of children born at 37 weeks or more who died with perinatal asphyxia, mainly within the countryside of the State, was significant. The deaths in newborns with adequate weight are considered a sentinel event, and can be avoided by simple and inexpensive interventions during labor and delivery[22,23]. Such measures also include the use of appropriate techniques for neonatal resuscitation, with the possibility of reducing neonatal mortality by asphyxia within 45% of cases[21].

The report of the Apgar score less than seven at 5 minutes of life in 71% of 2,548 infants who had this information available is a strong association observed in several studies, such as the Brazilian Neonatal Research Network[24]. It may express the time and degree of fetal distress or even ineffective implementation of neonatal resuscitation procedures due to the conditions of deficient infrastructure and human resources of health services, promoting death of newborns in the first 24 hours of life.

The care offered to newborns with asphyxia in the first hours of life is critical in the installation and progression of hypoxic-ischemic injury. The risk of death is two times higher at night than during the day, being four times higher in cases of asphyxia, due to lower medical and nursing teams, besides the state of fatigue[25,26]. In the present investigation, most births occurred during the day (58%), by vaginal delivery (55%), with death before 24 hours of life (63%), which demonstrate the compromised quality of health care both during the day and in the evening, from the delivery room to the NICU. Data from 2001 to 2003 show that in the state of São Paulo only a quarter of the hospitals had tertiary units, which not always had adequate equipment or exclusive environment for neonatal care, besides restricted availability of specialized medical teams in the follow-up of critically ill neonates[15].

The main limitation of this study was inherent to the collection of data from information provided by physicians on DCs and by institutions on LBCs, with likely underreporting of data[27]. Thus, knowledge about the process of care of pregnant women during labor, childbirth, and conditions of birth is limited. Furthermore, although data belong to the years 2001–2003, this is the first study in Brazil that covers the epidemiology of perinatal asphyxia or meconium aspiration syndrome observed on any line of the Death Certificate at the population level, showing the scenario of a cause of death that is preventable in the first 6 days of life.

The confirmation of death of one in five newborns related to meconium aspiration syndrome suggests the need for more studies, in order to understand more clearly the outcome of this group of patients and to plan specific strategies.

This research represents the regional inequity of the population in the state of São Paulo regarding newborns that died in the first week of life with hypoxia or asphyxia at birth, from 2001 to 2003. Such differences demand continuous monitoring of reality over time to contribute to the reduction of avoidable deaths caused by perinatal asphyxia.

Acknowledgement

To Margarete Silva Jordani and to Antonio Benedito Marangone Camargo, from SEADE Foundation, whose help was fundamental for data collection in the present research.

References

1. Lawn JE, Cousens S, Zupan J; Lancet Neonatal Survival Steering Team. 4 million neonatal deaths: When? Where? Why? Lancet 2005;891-900.
2. Malta DC, Duarte EC, Almeida MF, Dias MA, Morais Neto OL, Moura L *et al*. List of avoidable causes of deaths due to interventions of the Brazilian health system. Epidemiol Serv Saude 2007;16:233-44.
3. Lansky S, França E, Leal MC. Avoidable perinatal deaths in Belo Horizonte, Minas Gerais, Brazil, 1999. Cad Saude Publica 2002;18:1389-400.
4. Brenelli-Vitali MA, Castro R, Pavarin LB. Causas básicas de morte neonatal em uma maternidade de nível terciário: mudanças em uma década. Rev Cienc Med 2003;12:331-9.
5. Programa das Nações Unidas para o Desenvolvimento. PNUD Brasil [homepage on the Internet]. Tabelas de ranking do IDH-M [cited 2012 Feb 20]. Available from: http://www.pnud.org.br/atlas/ranking/IDH_Municipios_Brasil_2000.aspx?indiceAccordion=1&li=li_Ranking2003
6. Brasil. SEADE [homepage on the Internet]. População e estatísticas vitais [cited 2012 Feb 20]. Available from: http://www.seade.gov.br
7. World Health Organization [homepage on the Internet]. International statistical classification of diseases. 10th Revision (ICD-10) [cited 2012 Feb 20]. Available from: http://www.who.int/classifications/icd/en/
8. Lorenz JM. Survival of the extremely preterm infant in North America in the 1990s. Clin Perinatol 2000;27:255-62.
9. Niermeyer S, Kattwinkel J, Van Reempts P, Nadkarni V, Phillips B, Zideman D *et al*. International guidelines for neonatal resuscitation: an excerpt from the guidelines 2000 for cardiopulmonary resuscitation and emergency cardiovascular care: International consensus on science. Contributors and reviewers for the Neonatal Resuscitation Guidelines. Pediatrics 2000;106:e29.
10. World Health Organization [homepage on the Internet]. WHO statistical information system [cited 2012 Feb 20]. Available from: http://apps.who.int/whosis/data/Search.jsp?countries=%5bLocation%5d.Members/
11. Brasil. Ministério da Saúde. DATASUS [homepage on the Internet]. Informações de Saúde [cited 2012 Feb 202]. Available from: http://www2.datasus.gov.br/DATASUS/index.php?area=02/
12. Milsom I, Ladfors L, Thiringer K, Niklasson A, Odeback A, Thornberg E. Influence of maternal, obstetric and fetal risk factors on the prevalence of birth asphyxia at term in a Swedish urban population. Acta Obstet Gynecol Scand 2002;81:909-17.
13. Bhat RY, Rao A. Meconium-stained amniotic fluid and meconium aspiration syndrome: a prospective study. Ann Trop Paediatr 2008;28:199-203.
14. Qian L, Liu C, Zhuang W, Guo Y, Yu J, Chen H *et al*. Neonatal respiratory failure: a 12-month clinical epidemiologic study from 2004 to 2005 in China. Pediatrics 2008;121:e1115-24.
15. Conselho Regional de Medicina do Estado de São Paulo [homepage on the Internet]. Avaliação das condições de funcionamento dos hospitais e prontos-socorros 2001-2003 [cited 2012 Feb 20]. Available from: http://www.cremesp.org.br/library/modulos/publicacoes/pdf/avaliacao_condicoes.pdf
16. Lansky S, França E, Kawachi I. Social inequalities in perinatal mortality in Belo Horizonte, Brazil: the role of hospital care. Am J Public Health 2007;97:867-73.
17. Schoeps D, Almeida MF, Alencar GP, França Jr I, Novaes HM, Siqueira AA *et al*. Risk factors for early neonatal mortality. Rev Saude Publica 2007;41:1013-22.
18. Barros FC, Matijasevich A, Requejo JH, Giugliani E, Maranhão AG, Monteiro CA *et al*. Recent trends in maternal, newborn, and child health in Brazil: progress toward Millennium development goals 4 and 5. Am J Public Health 2010;100:1877-89.
19. Victora CG, Aquino EM, do Carmo Leal M, Monteiro CA, Barros FC, Szwarcwald CL. Maternal and child health in Brazil: progress and challenges. Lancet 2011;377:1863-76.
20. Soares VM, Azevedo EM, Watanabe TL. Underreporting of maternal deaths in Paraná state, Brazil: 1991-2005. Cad Saude Publica 2008;24:2418-26.
21. Darmstadt GL, Bhutta ZA, Cousens S, Adam T, Walker N, de Bernis L *et al*. Evidence-based, cost-effective interventions: how many newborn babies can we save? Lancet 2005;365:977-88.
22. Lansky S, França E, César CC, Monteiro Neto LC, Leal MC. Perinatal deaths and childbirth healthcare evaluation in maternity hospitals of the Brazilian Unified Health System in Belo Horizonte, Minas Gerais, Brazil, 1999. Cad Saude Publica 2006;22:117-30.
23. Drumond EF, Machado CJ, França E. Early neonatal mortality: an analysis of multiple causes of death by the grade of membership method. Cad Saude Publica 2007;23:157-66.
24. Almeida MF, Guinsburg R, Martinez FE, Procianoy RS, Leone CR, Marba ST *et al*. Perinatal factors associated with early deaths of preterm infants born in Brazilian network on neonatal research centers. J Pediatr (Rio J) 2008;84:300-7.
25. Heller G, Misselwitz B, Schmidt S. Early neonatal mortality, asphyxia related deaths, and timing of low risk births in Hesse, Germany, 1990-8: observational study. BMJ 2000;321:274-5.
26. Pasupathy D, Wood AM, Pell JP, Fleming M, Smith GC. Time of birth and risk of neonatal death at term: retrospective cohort study. BMJ 2010;341:c3498.
27. Almeida MF, Alencar GP, Novaes HM, Ortiz LP. Information systems and perinatal mortality: concepts and conditions for the utilization of data in epidemiological studies. Rev Bras Epidemiol 2006;9:56-68.