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Avoidable deaths in the first 24 hours of life: health care reflexes

Mortes evitáveis nas primeiras 24 horas de vida: reflexos da assistência à saúde

Muertes evitables en las primeras 24 horas de vida: reflejos asistenciales

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ABSTRACT

Objectives: to analyze the risks of deaths in the first 24 hours of life and their preventable causes. **Methods:** cross-sectional study carried out in Pernambuco, Northeast of Brazil, between 2000-2019, with mortality and live birth data. The avoidability was analyzed through the Brazilian List of Avoidable Causes of Deaths due to Interventions of the Unified Health System. For the statistical analyses, Pearson's chi-squared test and relative and attributable risks were used. **Results:** 13,601 deaths were registered, of which 10,497 (77.19%) were from preventable causes. Of the total, 5,513 (40.53%) were reducible through adequate care for women during pregnancy. The lower the gestational age, birth weight and education level, the higher the relative and attributable risk of death in the first 24 hours of life. **Conclusions:** most of the deaths were considered avoidable and with high relative and attributable risks. These early deaths suggest care failures and the need to reinforce prevention and treatment measures. **Descriptors:** Causes of Death; Child Mortality; Neonatal Mortality; Information Systems; Vital Statistics.

RESUMO

Objetivos: analisar os riscos de mortes nas primeiras 24 horas de vida e suas causas evitáveis. **Métodos:** estudo transversal realizado em Pernambuco, Nordeste do Brasil, entre 2000-2019, com dados de mortalidade e nascidos vivos. Analisou-se a evitabilidade pela Lista Brasileira de Causas de Mortes Evitáveis por Intervenções do Sistema Único de Saúde. Para as análises estatísticas, utilizou-se o teste de Qui-quadrado de Pearson e os riscos relativo e atribuível. **Resultados:** registraram-se 13.601 óbitos, sendo 10.497 (77,19%) por causas evitáveis. Do total, 5.513 (40,53%) eram reduzíveis por adequada atenção à mulher na gestação. Quanto menor a idade gestacional, o peso ao nascer e a escolaridade, maior o risco relativo e atribuível ao óbito nas primeiras 24 horas de vida. **Conclusões:** a maior parte dos óbitos foram considerados evitáveis e com elevados riscos relativo e atribuível. Esses óbitos precoces sugerem falhas assistenciais e a necessidade de reforçar as medidas de prevenção e tratamento.
Descritores: Causas de Morte; Mortalidade Infantil; Mortalidade Neonatal; Sistemas de Informação; Estatísticas Vitais.

RESUMEN

Objetivos: analizar los riesgos de muerte en las primeras 24 horas de vida y sus causas prevenibles. **Métodos:** estudio transversal realizado en Pernambuco, Nordeste de Brasil, entre 2000-2019, con datos de mortalidad y nacidos vivos. La evitabilidad fue analizada por la Lista Brasileña de Causas de Muerte Evitables por Intervenciones del Sistema Único de Salud. Para los análisis estadísticos se utilizó la prueba de chi-cuadrado de Pearson y los riesgos relativos y atribuibles. **Resultados:** fueron registradas 13.601 muertes, de las cuales 10.497 (77,19%) se debieron a causas evitables. Del total, 5.513 (40,53%) fueron reducibles mediante una atención adecuada a la mujer durante el embarazo. Cuanto menor es la edad gestacional, el peso al nacer y el nivel educativo, mayor es el riesgo relativo y atribuible de muerte en las primeras 24 horas de vida. **Conclusiones:** la mayoría de las muertes se consideraron evitables y de alto riesgo relativo y atribuible. Estas muertes precoces sugieren fallas en la atención y la necesidad de reforzar las medidas de prevención y tratamiento.
Descriptores: Causas de Muerte; Mortalidad Infantil; Mortalidad Neonatal; Sistemas de Información; Estadísticas Vitales.

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INTRODUCTION

Neonatal mortality, deaths of children up to 28 days after birth, encompasses the effect of socioeconomic and environmental factors on newborns and mothers, and the responsiveness of the health systems. The risk of a child's death is greatest in the neonatal period, which accounts for almost half of deaths in children under five years of age. In addition, more than 80% of newborn deaths result from preventable and treatable conditions[1].

The Sustainable Development Goals (SDGs) set the goal of reducing neonatal mortality to 12 deaths or less per 1,000 live births by 2030[2]. Worldwide, the neonatal mortality rate dropped from 36.6 in 1990 to 18.0 deaths per 1,000 live births in 2017, representing a reduction of 51%[2]. Between 2018 and 2030, it is projected that 22.8 million newborns will die if each country achieves the SDG mortality target[2].

In Brazil, neonatal deaths represent more than 60% of all infant deaths and their reduction is a concern for the country[3]. Research that analyzed the inequalities in infant mortality in the country showed a reduction in the mortality rate for the regions; however this decline is less evident for the neonatal component, with a concentration of deaths in the early neonatal period[4]. In the period from 2007 to 2017, 303,260 neonatal deaths were recorded, with an average mortality rate of 9.46 per 1,000 live births, with an annual reduction trend of 2.15%[5]. However, component analysis showed that the decline was less pronounced for the neonatal mortality rate. The mean early neonatal mortality rate was 7.20 per 1,000 live births and the late one was 2.26 per 1,000 live births[5].

In the Northeastern region of Brazil, the behavior is similar to that found in the country and in other regions, with a tendency to reduce infant mortality and its components and a greater decrease in the post-neonatal period[6]. In this way, neonatal deaths persist as a public health problem because they show a slower decreasing trend when compared to post-neonatal deaths[7]. Moments close to birth constitute the period of greatest risk for death, as they require appropriate and timely care and interventions, constituting the period of greatest risk for death[8].

The determinants of neonatal mortality are of different natures: biological, social, economic and of assistance[9]. A hierarchical conceptual model applicable to developing countries categorizes the determinants into levels: distal (with socioeconomic risk factors), intermediate (concerning care) and proximal (maternal and newborn biological conditions)[10].

The influence of factors at each level differs for the components of child mortality[3]. Deaths that occur in the first 24 hours of life have a strong determination of proximal factors, which represent the biological conditions of the neonate and the mother[11]. Low birth weight and Apgar score, sex, perinatal asphyxia, congenital malformation, prematurity are some[11]. In addition to these, other factors that may be linked to maternal condition that favor neonatal mortality are: low nutritional status, alcoholism, smoking and illicit drugs, previous neonatal death, education and marital status. Added to these, are the difficulty in accessing adequate and timely maternal and neonatal care[12].

Methods and classification lists were constructed to discuss the prevalent causes of child and neonatal death and provide the planning of strategies to prevent them[8]. The first method classifies avoidability into two major axes: clearly preventable conditions (among them, infant deaths) and limitedly preventable conditions (such as neoplasms)[13].

The applicability of validated instruments that allow classifying deaths according to avoidability criteria, such as the Brazilian List of avoidable causes of Deaths due to Interventions of the Brazilian Health System (SUS), is a powerful management tool in public health[14]. It enables the identification of the main assistance barriers for the adequate planning of effective interventions aimed at reducing deaths during intrapartum, peripartum and immediate after birth moments, such as critical care periods[15].

The day of birth is considered to be the most risky for survival. Although much progress has been made in the area of maternal and child health, the first day of life has been relatively neglected in certain regions of the world[16]. Research on the causes and risk factors of neonatal deaths identified that 76% of neonatal deaths were early, and 25% occurred on the first day of life[17]. The current study fills the gap on causes of death, preventability and variables associated with deaths occurring in the first 24 hours of life. Although child mortality is widely studied, the focus on deaths in the first 24 hours of life does not always emerge with the expression of its specificities and characteristics. Assessments that show the critical care points for this age group can contribute to the reduction of avoidable deaths.

OBJECTIVES

To analyze the variables related to the pregnant woman, the live birth and delivery and the avoidable causes with the death occurring in the first 24 hours of life.

METHODS

Ethical aspects

The research protocol was approved by the Research Ethics Committee of the Federal University of Pernambuco, in accordance with ethical principles for research with human beings contained in Resolution nº 466/2012 of the National Health Council.

Design, period and place of study

This is a cross-sectional study, corresponding to the period from 2000 to 2019, carried out in the state of Pernambuco, located in the Northeast region of Brazil, with a territorial area of 98.068,021 km^2[18]. The state is composed of 184 municipalities and the state district of Fernando de Noronha, distributed in five mesoregions: Agreste (71 municipalities), Mata (43 municipalities), Recife Metropolitano (15 municipalities), São Francisco (15 municipalities) and Sertão (41 municipalities). In 2020, the estimated population of the state was 9,616,610 inhabitants, of which 4,990,400 are female, 3,187,854 (63.9%) are women

of reproductive age (10 to 49 years). The Human Development Index (HDI) of Pernambuco is 0.673, and more than half of the municipalities are in the low range of the HDI (from 0.500 to 0.599)[18]. The guidelines for Observational Studies in Epidemiology (STROBE) were used.

Database

The data sources were the Mortality Information Systems (SIM) and About Live Births (Sinasc), available on the website of the Informatics Department of the Unified National Health System (DATASUS) through the access link: https://datasus.saude.gov.br/[19]. SIM and Sinasc files are publicly available according to the year of birth or death. Developed by the Ministry of Health, SIM and Sinasc are the national systems of vital statistics that contribute to the characterization of birth and mortality conditions in Brazil[4]. SIM is fed with information from death certificates, while Sinasc has the declarations of live births as a data collection instrument[20]. There is a tendency of improvement in the quality of the records of these systems observed in a recent period, with completeness of the fields above 96%[4]. In addition, child deaths recorded in SIM increased from 52.0% to 88.5% in 2015[4].

Population, inclusion and exclusion criteria

All deaths in the first 24 hours of life that occurred between January 1, 2000 and December 31, 2019 were included in the study, totaling 13,601 deaths. These deaths had their underlying cause classified according to the International Statistical Classification of Diseases and Related Health Problems (ICD-10), and were later categorized with the Brazilian List of avoidable Causes of Death due to SUS Interventions[14].

Study Protocol

A spreadsheet database was created in the *Microsoft Excel* program. Deaths that occurred in the first 24 hours of life were distributed by year and month of occurrence and according to the following independent variables: gestational age in weeks, <22 (reference category), 22 to 27, 28 to 36, ≥37; sex, female (reference category) and male; birth weight in grams, <1,500 (reference category), 1,500 to 2,499, ≥2,499; type of pregnancy, singlet, double, triple or more (reference category); type of delivery, vaginal (reference category) and c-section; maternal age in years, 10 to 19 (reference category), 20 to 34, ≥35; and, maternal schooling in years of education, without schooling (reference category), 1 to 3, 4 to 7, 8 to 11, ≥12.

The List of Avoidable Causes of Deaths due to SUS Interventions in Brazil was created in 2007 by specialists and was last updated in 2010. The causes are separated into two age groups: those under five years old and those over five years old up to 75 years old, with the proposed limit based on Brazilian life expectancy. The three major groups of causes were: avoidable causes, ill-defined causes and other causes (not clearly avoidable) [14]. This instrument gave visibility to the process of monitoring and evaluating health services, so that they could be research objects for future studies[14].

The avoidability of deaths that occurred in the first 24 hours of life was analyzed from the Brazilian List of avoidable Causes of Death due to SUS Interventions for children under 5 years of age, which classifies deaths into three groups of causes: avoidable, ill-defined and other causes of death (not clearly avoidable). Preventable causes were categorized according to the following groups: reduced by immunoprevention actions, reduced by adequate care for women during pregnancy and childbirth, the fetus and newborn, reduced by adequate diagnostic and treatment actions, and reduced by adequate actions of health promotion, linked to adequate health care actions[14].

Analysis of results and statistics

The variables were analyzed through the distribution of frequencies (absolute and relative) corresponding to the study's period (2000 to 2019). To analyze the associated factors, the study variables were described based on the levels proposed in the Henry Mosley and Lincoln Chen model: proximal, intermediary and distal[4].

The association between the independent variables and the death outcome was verified using Pearson's chi-squared test, testing the null hypothesis that the frequency of deaths occurring in the first 24 hours of life is equal in the independent variables, considering a level of statistical significance of 5%. The magnitude of the relationship was assessed by the relative risk and attributable risk and delimiting the respective confidence intervals (95% CI). The basis for calculating the relative risk, for all variables, considered the exposure rate in the numerator and the non-exposure rate in the denominator (reference variable). The attributable risk represents the difference between these rates, which considers the number of deaths that had the most resulting from the independent variable in question. The program used in this step was Epi Info version 7.2.3.1.

RESULTS

During the study period, 52,831 child deaths were recorded. Of these, 13,601 (25.74%) occurred in the first 24 hours of life, with 10,497 (77.19%) being due to avoidable causes. The variables at the proximal level: gestational age <22 weeks (attributable risk = 855.01) and birth weight <1,500 grams (attributable risk = 204.03) represent an important portion of deaths that occurred in the first 24 hours of life (Table 1).

The variables gestational age, sex, birth weight, type of pregnancy, type of labor, mother's age and maternal education were associated with death in the first 24 hours of life ($p<0.01$), as shown in Table 1.

Of the total number of deaths analyzed, 10,497 (77.19%) occurred due to avoidable causes. Deaths could have been reduced by adequate care for women during pregnancy (n=5,513), which represents a proportion of 40.53% (Table 2). The main cause of mortality (n=1,534; 11.28%) was disorders related to short-term pregnancy and low birth weight.

Table 1 – Variables related to pregnant women, live births and childbirth with death occurring within the first 24 hours according to the levels proposed in the hierarchical conceptual model, Pernambuco, Brazil, 2000-2019

Variables	n (%)	LB[a]	Rate	RR[b]	AR[c]	*p* value*
DISTAL						
Maternal Education (in years of study)						<0.01
No education	1,011 (7.43)	111,091	9.10	3.37 (3.08;3.69)	6.40 (5.81;6.99)	
1 to 3	1,538 (11.31)	318,818	4.82	1.79 (1.65;1.94)	2.12 (1.83;2.43)	
4 to 7	3,879 (28.52)	907,848	4.27	1.58 (1.47;1.70)	1.57 (1.36;1.80)	
8 to 11	4,112 (30.23)	1,181,929	3.48	1.29 (1.20;1.39)	0.78 (0.58;0.99)	
≥12	912 (6.71)	338,175	2.70	1.00	(Reference)	
INTERMEDIARY						
Type of labor						<0.01
Vaginal	9,612 (70.67)	1,634,034	5.88	1.00	(Reference)	
C-section	2,949 (21.68)	1,261,935	2.34	0.40 (0.38;0.41)	-3.54 (-3.69; -3.40)	
PROXIMAL						
Gestational Age (in weeks)						<0.01
< 22	1,488 (10.94)	1,738	856.16	744.48 (715.35;775.80)	855.01 (838.51;871.51)	
22 to 27	3,629 (26.68)	11,842	306.45	266.48 (254.97;278.87)	305.30 (297.00;313.61)	
28 to 36	4,026 (29.60)	216,443	18.60	16.17 (15.44;16.96)	17.45 (16.88;18.02)	
≥37	3,012 (22.15)	2,620,821	1.15	1.00	(Reference)	
Sex						<0.01
Male	7,604 (55.91)	1,484,230	5.12	1.26 (1.21;1.30)	1.04 (0.88;1.19)	
Female	5,776 (42.47)	1,414,101	4.08	1.00	(Reference)	
Birth Weight (in grams)						<0.01
< 1.500	7,089 (52.12)	34,553	205.16	181.56 (174.34;189.34)	204.03 (199.78;208.29)	
1.500 to 2.499	2,289 (16.83)	186,425	12.28	10.87 (10.30;11.48)	11.15 (10.65;11.65)	
≥2.500	3,017 (22.18)	2,671,807	1.13	1.00	(Reference)	
Type of Pregnancy						<0.01
Singlet	11,341 (83.38	2,844,106	3.99	1.00	(Reference)	
Double	1,221 (8.98)	51,240	23.83	5.97 (5.64;6.34)	19.84 (18.52;21.16)	
Triple or more	62 (0.46)	1,481	41.86	10.49 (8.22;13.40)	37.87 (27.68;48.08)	
Maternal Age (in years)						<0.01
10 to 19	3,351 (24.64)	640,631	5.23	1.38 (1.33;1.44)	1.44 (1.25;1.64)	
20 to 34	7,512 (55.23)	1,983,743	3.79	1.00	(Reference)	
≥35	1,278 (9.40)	273,865	4.67	1.23 (1.16;1.31)	0.88 (0.61;1.14)	

*[a]LB – live birth; [b]RR – relative risk; [c]CI – Confidence Interval 95%; [d]AR – attributable risk; *p-value with respect to Pearson's Chi-squared test.*
Source: Mortality Information System and Live Birth Information System (2000-2019).

Table 2 - Deaths occurring in the first 24 hours of life according to the groups of causes of death on the List of Avoidable Causes of Deaths due to Interventions of the Brazilian Health System, Pernambuco, Brazil, 2000-2019

1. AVOIDABLE CAUSES	10,497 (77.19)
1.1 Reduced by immunoprevention actions	3(0.02)
Congenital Rubella Syndrome	2 (0.01)
Meningitis caused by *Haemophilus*	1 (0.01)
1.2 Reduced by adequate care for women during pregnancy	5,513 (40.53)
Disorders related to short-term pregnancy and low birth weight	1,534 (11.28)
Respiratory distress syndrome of the newborn	1,146 (8.43)
Maternal pregnancy complications that affect the fetus or newborn	1,118 (8.22)
Maternal conditions affecting the fetus or newborn	911 (6.70)
Fetus and newborns affected by complications of the placenta and membranes	561 (4.12)
Congenital syphilis	83 (0.61)
Delayed fetal growth and fetal malnutrition	59 (0.43)
Pulmonary hemorrhage originating in the perinatal period	45 (0.33)
Hemolytic diseases of the fetus or newborn due to isoimmunization	21 (0.15)
Rh and ABO isoimmunization of the fetus or newborn	17 (0.12)
Non-traumatic intracranial hemorrhage of the fetus and newborn	11 (0.08)
Human immunodeficiency virus diseases	1 (0.01)
1.3 Reduced by adequate care for women in childbirth	2,639 (19.40)
Intrauterine hypoxia and birth asphyxia	1,502 (11.04)
Neonatal aspiration (except regurgitated breast milk)	406 (2.99)
Placenta previa and placental abruption	323 (2.37)
Other complications of labor or delivery that affect the newborn	209 (1.54)
Fetus and newborn affected by umbilical cord disorders	151 (1.11)
Delivery trauma	47 (0.35)
Disorders related to prolonged pregnancy and high birth weight	1 (0.01)

To be continued

Table 1 (concluded)

1.4 Reduced by adequate attention to the fetus and the newborn	2,263 (16.64)
Respiratory disorders specific to the perinatal period	1,474 (10.84)
Specific infections of the perinatal period (except for MMR** and congenital viral hepatitis)	466 (3.43)
Conditions that compromise the integument and thermal regulation of the newborn	101 (0.74)
Other disorders originating in the perinatal period	100 (0.74)
Neonatal hemorrhage	43 (0.32)
Newborn and specific transient endocrine and metabolic disorders	35 (0.26)
Hematological disorders of the newborn	29 (0.21)
Digestive system disorders of the newborn	13 (0.10)
Other perinatal jaundices	2 (0.01)
1.5 Reduced by adequate diagnostic and treatment actions	21 (0.15)
Down's syndrome	14 (0.10)
Pneumonia	3 (0.02)
Other bacterial diseases	3 (0.02)
Acute upper airway infections	1 (0.01)
1.6 Reduced by adequate health promotion actions, linked to adequate health care actions	58 (0.43)
Sudden infant death syndrome	21 (0.15)
Events whose intent is intermediary	14 (0.10)
Aggression	9 (0.07)
Accidental Falls	6 (0.04)
Intestinal Infectious Diseases	3 (0.02)
Nutritional Deficiencies	2 (0.01)
Other accidental respiratory risks	2 (0.01)
Transport Accidents	1 (0.01)
Total avoidable deaths	10,497 (77.2)
2. OTHER CAUSES (NOT CLEARLY AVOIDABLE)	2,701 (19.86)
3. ILL-DEFINED CAUSES OF DEATH	403 (2.96)
Total deaths	13,601 (100)

**Proportion in relation to total deaths in the first 24 hours (n=13.601); **MMR – Measles, Mumps and Rubella.*
Source: List of avoidable causes of deaths due to interventions of the Brazilian Health System (2000-2019).

DISCUSSION

The results of the study showed that about a quarter of all recorded child deaths occurred within the first 24 hours of life and the main cause of death was disorders related to short-term pregnancy and low birth weight. The highest proportion of neonatal deaths corresponds to that found in the literature[20-21]. Research on the tendency, distribution and associated factors conducted in Jordan identified that almost half of neonatal deaths occurred on the first day of life[20]. The analysis of factors related to the cause and period of neonatal death showed that approximately 30% occurred on the first day of life and 65% within the first week[21]. In Brazil, a study conducted in eight Brazilian states identified an average proportion of 21.6% of neonatal deaths on the first day of life[16]. Although the proportions are different, these studies and ours are similar in showing the importance of the first day of life for the survival of newborns[20].

In 2019, around 5.2 million children under the age of 5 died, mostly from avoidable causes. Of this total, 2.4 million occurred in the neonatal period, representing 47% of all deaths. The majority of all newborn deaths (75%) occur during the first week of life, and about one million newborns die within the first 24 hours[1]. In addition, 35% of neonatal deaths were due to complications associated with preterm birth. To improve neonatal survival, it is necessary to invest in prenatal to postnatal care for mothers and their newborns. This involves factors related to Education, Nutrition and Maternal Health, as well as investments in health infrastructure[2].

The live births with the highest risk of death in the first 24 hours of life were those with a gestational duration of less than 22 weeks, males, very low birth weight (<1,500g), with three or more pregnancies, vaginal delivery, maternal age equal to or over 35 years old and pregnant women with no schooling in years of study. Likewise, Garcia et al. (2019), analyzing risk factors for neonatal mortality, based on the model proposed by Henry Mosley and Lincoln Chen[10], also found prematurity and low birth weight associated with death. Systematic review research on risk factors for neonatal mortality in Brazil identified prematurity, low birth weight and maternal age over 35 years, and multiple pregnancies[11]. Recognizedly, prematurity (<37 weeks of gestation) and low birth weight are risk factors for neonatal mortality, in addition to being potentially avoidable[11,22-23]. To reduce prematurity and low birth weight, improving the quality of maternal and child care, especially in prenatal care, is essential.

Other previous studies also showed that the attributable risk related to the level of maternal education contributed to the occurrence of deaths that happened in the first 24 hours of life[24]. Neonatal mortality is strongly associated with maternal schooling[25-26]. A systematic review study found that attending Primary School was associated with a 28% reduction in the probabilities of child mortality compared to babies born without schooling. In turn, attending Secondary and Higher Education was associated with a 45% reduction in the odds of child mortality compared to babies born to uneducated mothers[25]. In the state of São Paulo, Brazil, a research that analyzed maternal characteristics associated with neonatal mortality identified that there was an increase of 20% and 11% in the mortality rate related, respectively, to maternal schooling <7 years and 8-11 years[26].

The effect of maternal schooling on child survival can be explained in different dimensions, such as: economic, demographic, social, environmental and biomedical[27]. Higher maternal schooling implies access to resources and knowledge that can

translate into greater use of health services and health-seeking behaviors[27]. In addition, maternal schooling is used as a proxy for socioeconomic status and applied to describe social inequalities, allowing to know the magnitude of child mortality[24]. Socioeconomic inequality can lead to differences in prenatal risk factors, including accessibility and quality of maternal care, maternal health behaviors, and occupational status, nutrition, and health outcomes[28]. In fact, there is a positive relationship in the search for care assistance that favors a healthy pregnancy with fewer risks[26].

The multiparity found in the study as variables associated with death is evidenced in other locations that share the same socioeconomic status[29]. This variable is associated with inequalities in access to education, care and reproductive rights, making women and their newborns a more vulnerable group to adverse outcomes[26].

In this study, the main causes of death were disorders related to short-term pregnancy and low birth weight, as well as intrauterine hypoxia and birth asphyxia. These are causes considered preventable due to adequate care for women during pregnancy. These are causes associated with endogenous and biological factors, directly related to the maternal and newborn condition. The respiratory system is one of the last sets of organs to achieve functional development in fetal life[30]. The explanation for preterm birth presenting a higher probability of death when compared to full-term pregnancy is due to the fact that preterm neonates are not able to adapt to extra uterine life, due to poor pulmonary maturation, resulting in the inability to breathing and hypoxia, ending with death[31].

Among the biological variables, disorders related to short-term pregnancy and low birth weight explain a significant proportion of deaths that occur in the first 24 hours of life. This result corroborates evidence from a survey conducted in eight Brazilian states, in which live preterm children with birth weights below 1,500g had the highest mortality rate on the first day of life[16]. Furthermore, a systematic review on risk factors for neonatal mortality in Brazil showed that low birth weight is the main isolated predictor for the occurrence of neonatal mortality in the country[11].

Another evidence was found in a cohort carried out in the state of Goiás, which showed that the variables prematurity and low birth weight had the highest odds ratio in the neonatal period. This high magnitude is related to the proximity of determination of these early deaths[32]. The condition of low birth weight (2,500 grams) is directly and indirectly related to the underlying pathologies in the gestational period[33]. In Uruguay, it was evidenced, in the historical series from 2009 to 2015, that arterial hypertension and hypertensive disorders in pregnancy, such as preeclampsia, increased the chances of low birth weight[33].

Intrauterine hypoxia and asphyxia at birth were the main preventable causes of death among those reduced by adequate care for women during childbirth. This can be explained by the greater vulnerability of premature and low birth weight children[34]. The causes of neonatal deaths, especially those occurring in the first week of life, are related to prenatal care and childbirth[34], in addition to the weaknesses in the maternal and child care network of the Brazilian Health System, which does not link 43% of pregnant women to reference maternity hospitals for childbirth[34].

The present study has showed that avoidable deaths accounted for more than half of all deaths in the first 24 hours of life. This finding coincides with that found in a study on the tendency, causes and preventability of deaths on the first day of life, in which more than 60% of deaths were considered avoidable[16]. The analysis of the underlying cause from the perspective of preventability allows identifying challenges in reducing neonatal deaths by explaining the obstacles in health care[15]. Care improvements through cost-effective and timely investments for women's health care services that assist pregnant women and newborns are essential for reversing the situation[35].

It was observed that most neonatal deaths in the first 24 hours of life could have been avoided if the care continuum had been guaranteed through integrated services that include maternal and newborn care (prenatal care, specialized care in childbirth and immediate postnatal care)[23]. Investment in strategies to assess critical care points and to identify variables associated with neonatal deaths and their preventable causes can support the structuring and reorganization of the maternal and neonatal health care network[15].

Early and potentially avoidable deaths require universal public interventions and guaranteed care that positively impact the reduction of mortality[24]. In the state of Pernambuco, the *Rede Cegonha and Mãe Coruja* programs had positive effects in reducing child mortality and its components. However, the regionalization of these strategic actions did not have a homogeneous repercussion in the state, given the assistance gaps in the interior of the state[24].

The hegemonic care model of institutionalization of childbirth requires effective obstetric and neonatal measures that reduce unfavorable outcomes for mothers and newborns[21]. Based on this finding, in 2011, the *Rede Cegonha* was structured, one of the strategies aimed at reducing maternal and child mortality, especially the newborn component[25]. This public health policy expanded access to technologies for childbirth and birth, such as the guarantee of childbirth assisted by a multidisciplinary team and the installation of Normal Birth Centers[21].

The avoidable early deaths found in the study reflect health inequities, which are attributed to socioeconomic, biological and care inequalities[36]. The proportion of avoidable deaths represented by adequate care for women during pregnancy, childbirth, the fetus and the newborn indicates that there are important care failures in the conduct of a healthy birth[36].

Study Limitations

The limitations of the study refer to the secondary databases available in the information systems of the Ministry of Health, although in the state of Pernambuco there are important advances regarding the SIM[27]. This implies problems of coverage, regularity, completeness and quality of the data, which may limit the association of explanatory variables with death. As a way of minimizing this limitation, variables whose percentage of incompleteness was less than 15% were included in the study. In this way, the results documented in the study can contribute to knowing the main causes of death and from avoidable causes and can be a tool that subsidizes the planning of maternal and child health actions in the state of Pernambuco.

Contributions to the field of Nursing

The results of the present study can contribute to the identification of variables associated with premature death and, consecutively, of care directed to newborns, reducing the negative outcomes of morbidity and mortality, in addition to enabling the development and/or improvement of care protocols for maternal and child health in the conduct of nursing practice. Furthermore, dealing with such early and potentially preventable deaths is challenging in care. Therefore, the applicability of identifying situations that increase the risk of early death becomes fundamental in the inclusion in the Nursing work process, allowing the lead to diagnoses that make it possible to prevent these deaths.

CONCLUSIONS

The results of the study show that deaths occurring in the first 24 hours of life are determined by different variables. Avoidability reflects the degree of social vulnerability, which is enhanced in contexts of reduced resources for public policies. In this way, we suggest that, in order to avoid such early deaths, the results point to the conduction of assistance policies invested in the care provided in all cycles that permeate birth, especially in prenatal care and childbirth.

The avoidability approach used in the present study, through the Brazilian List of Preventable Causes of Deaths due to Interventions of the Unified Health System, as an instrument available for analysis, becomes a health management tool. It was observed that the distribution of frequencies by avoidable causes according to the list highlighted the importance of causes related to health care during pregnancy, childbirth and care provided directly to the newborn.

We add that the avoidable causes or causes not involved in death in the first 24 hours of life involve the socioeconomic dimension and that, therefore, the development of studies that aim to analyze this association becomes relevant.

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