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ORIGINAL ARTICLE

Perinatal mortality: analysis of necropsies from 2018 to 2022

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Abstract

Objectives: characterize the sociodemographic profile of the study population; analyze the cause of death described in the report; identify the events that contributed to the death; evaluate the quality of the completion of the Death Certificate (DC) and verify the prenatal follow-up of these children. **Methods:** cross-sectional study, using secondary data from necropsy reports performed at the Criciúma and Tubarões Death Verification Services. Individuals with death between 22 weeks of gestation and the sixth day of life were included, excluding those with more than 50% of the report without completion. The information present in the DC, necropsy reports and complementary tests were evaluated. **Results:** a total of 212 necropsy reports were evaluated. Among these, 51,4% corresponded to females and 87,7% were caucasians. The majority (85.5%) of the cases analyzed were fetal deaths, with complications of the placenta, umbilical cord and membranes (ICD P02) being the main cause with 73,1% of the cases. There was a lack of completion of intermediate causes in 84,4%, and significant conditions that contributed to death in 98,5% of the reports. Regarding prenatal care, 89.6% underwent follow-up. **Conclusion:** it is emphasized that perinatal mortality is a crucial indicator for prenatal evaluation and factors related to mother and pregnancy. This is because it will be through epidemiological information related to it that public resources will be distributed, in order to reduce the diseases and improve health indicators.

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INTRODUCTION

The term perinatal mortality can be defined as the number of deaths between the twenty-second week of gestation and the sixth day of life for every thousand live births in a given period. Health services in Brazil have historically neglected perinatal death. Superior outcomes could have been achieved if the etiology of these deaths, connected to pregnancy and childbirth, had been better tended to¹.

The National Health Surveillance Policy (PNVS) was instituted to improve overall healthcare and strengthen the dissemination of information to enhance the adoption of measures to protect the population's health². Information systems were thus created to standardize patient monitoring and data collection³. The Mortality Information System (SIM), developed by the Ministry of Health, gathers quantitative and qualitative data on deaths in Brazil based on issued death certificates⁴.

The law requires that a death certificate be issued for every deceased person⁵. A relevant epidemiological document, the death certificate must contain references to the diseases, comorbid conditions, and injuries present in a deceased person as described by the physician filling it up^{6,7} to substantiate the stated cause of death per the International Classification of Diseases (ICD). However, this does not always happen. Unsatisfactory records are ever present, leading to epidemiological inconsistencies.⁵ To improve the quality of the information provided in death certificates, the Ministry of Health implemented the National Network of Death Verification and Cause of Death Services to provide diagnostic clarification and enhance the determination of the causes of death in nonviolent deaths and deaths during medical care⁸.

The investments made to improve the reporting of causes of death supported the expansion of prenatal care. According to the United Nations Sustainable Development Goals, high-quality prenatal care plays a fundamental role in the survival of women and infants.⁹ In Brazil, prenatal care is provided mainly via the Stork Network (Rede Cegonha), which offers free healthcare via the Brazilian Unified Health System (SUS) and ensures the adoption of good care practices in delivery and birth^{1,10}.

Despite these efforts, diseases such as syphilis, a condition that can be screened for and treated during prenatal care, continue to grow and cause perinatal death. In 2020, the death rate associated with congenital syphilis was 6.5 deaths per 100,000 live births in Brazil, with the North Region having the worst rate, with 10.2 deaths per 100,000 live births. Although the South Region had the lowest national rate, the death rate associated with congenital syphilis increased by more than 150% in ten years, going from 1.6 deaths per 100,000 live births in 2010 to 4.1 deaths per 100,000 live births in 2020¹¹.

This study describes the prenatal monitoring and epidemiological profile of fetuses and newborns who

died from 22 weeks of gestation to six days after birth to identify the mortality trends in this age group and improve the allocation of resources and practices that can improve healthcare and reduce adverse outcomes.

METHODS

This quantitative observational cross-sectional study used secondary data from autopsy reports issued by the coroner's office of Criciúma and Tubarão and the Health Department of the State of Santa Catarina from January 2018 to June 2022. They provide services to the Association of Municipalities of the Carboniferous Region (AMREC) – which includes the municipalities of Criciúma, Balneário Rincão, Cocal do Sul, Forquilha, Içara, Lauro Müller, Morro da Fumaça, Nova Veneza, Orleans, Siderópolis, Treviso and Urussanga – and the Association of Municipalities of the Laguna Region (AMUREL) – which includes the municipalities of Tubarão, Armazém, Braço do Norte, Capivari de Baixo, Grão-Pará, Gravatal, Imaruí, Imbituba, Jaguaruna, Laguna, Pedras Grandes, Pescaria Brava, Rio Fortuna, Sangão, Santa Rosa de Lima, São Ludgero, São Martinho, and Treze de Maio. This study followed the ethical research principles stipulated in resolution 466/12 of the National Health Council (CNS)¹². The study's benefits outweighed the potential harms derived from its results and discussion. The data were collected from databases containing anonymized aggregate information. Therefore, as stated in CNS resolution 510/16 article V¹³, the study did not require a Research Ethics Committee appraisal. A request to waive the need to fill Free and Informed Consent Forms (FICF) was approved in opinion 5,178,906. The study began after approval by a Research Ethics Committee. It included the death certificates of individuals who died from 22 weeks of gestation to six days after birth, corresponding to the perinatal period. Death certificates missing more than 50% of the data fields were excluded. The study variables were divided into two groups: data from fetuses and infants and mothers and pregnancies. The following data about the first group were captured: sex, skin color, place of birth, weight, age, type of death, place of death, city of death, medical care provided before death, diagnosis confirmed by autopsy, immediate, intermediate, secondary and primary cause of death according to the International Classification of Diseases Tenth Revision (ICD-10), malformations on internal and external examination, Galen's hydrostatic test for infant live birth, and results of complementary workup. In the second group, the variables considered were as follows: age, schooling, employment status, number of live births, number of lost pregnancies or miscarriages, weeks of gestation, type of pregnancy, type of delivery, prenatal care, and number of prenatal care visits. The data sets were initially processed on Windows Excel and subsequently analyzed in SPSS Version 21. Descriptive statistics was used to calculate frequencies for categorical variables and measures of central tendency and dispersion. Differences in

proportions were tested using the Chi-square test (X²). The level of statistical significance adopted was 5% (p-value < 0.05).

RESULTS

A total of 212 autopsy reports were evaluated. Of these, 109 (51.4%) belonged to females and 186 (87.7%) to white individuals, as seen in Table 1. Most of the autopsy reports belonged to individuals born in Criciúma (72.6%), with the hospital being the place of death in all cases. Two hundred and four (96.2%) were under medical care at the time of death. Most individuals died in utero, with 182 (85.8%) fetal deaths. Galen's hydrostatic test for infant live birth was negative in 156 (73.6%) cases. The average time of life was 41.39 minutes (SD=249.331), ranging from 0 to 3,330 minutes, and the average weight was 1,500 grams (SD=1,031.36), ranging from 103 grams to 5,150 grams.

In one case, an autopsy was not performed to determine the cause of death. In all other cases, the cause of death was defined based on an autopsy and assigned an ICD-10 diagnostic code. In most of the subjects (73.1%), the immediate cause of death was complications of the placenta, cord, and membranes (P02). An intermediate cause of death was not described in 179 coroner reports (84.4%). Considering the complete ones, extreme immaturity (P07.2) was cited in nine records (4.2%). The only significant conditions that contributed to death were type 2 diabetes mellitus (E11), multiple congenital malformations not elsewhere specified (Q89.7), and congenital malformations of cardiac septa (Q21), each with one record (0.5%), as seen in Table 2.

According to the autopsy reports, ectopic malformations were found in 18 individuals (8.5%). Defects of the face and ears were described in 12 cases (5.7%), and central nervous system and skull alterations were present in eight (3.8%). In internal examination, malformations were found in 11 (5.2%) subjects, seven of which (3.3%) were respiratory, five (2.4%) urinary, and five (2.4%) cardiovascular. Two subjects had more than one alteration described. Confirmatory tests were performed on 158 (74.5%) subjects. Pathological examinations were performed in all such cases. Ninety-nine (46.7%) subjects had hemodynamic and metabolic disorders of the placenta and annexes, followed by fibrin deposition (35.8%), inflammatory disorders (17.5%), and other findings (5.2%). Umbilical cord analysis also showed hemodynamic and metabolic disorders of the placenta and annexes as the most prevalent finding, with 13 (6.1%) cases. Only one case (0.5%) of inflammatory disorder was found. Only seven (3.3%) subjects had other tissue specimens analyzed, namely the lungs, liver, and kidneys. Rapid COVID-19 testing was performed with blood collected from the heart chambers in three (1.4%) cases, two (0.9%) of which tested positive.

The average maternal age was 29.08 years (SD=6.902), ranging from 16 to 52. Most (51.9%) completed high school,

Table 1. Perinatal death: sociodemographic data of infants and fetuses registered with the coroner's office of Tubarão and Criciúma between 2018 and 2022.

Variables	N	%
Sex		
Female	109	51.4
Male	103	48.6
Skin color		
White	186	87.7
Brown	7	3.3
Black	19	9.0
Place of birth		
Criciúma	154	72.6
Other AMREC municipalities	34	16.1
Tubarão	23	10.8
Other AMUREL municipalities	1	0.5
Place of death		
Hospital	212	100
Medical care		
Yes	204	96.2
No	2	0.9
Not informed	6	2.8
Type of death		
Fetal	182	85.8
Non-fetal	30	14.2
Galen's hydrostatic test for infant live birth		
Positive	36	17
Negative	156	73.6
Not performed	20	9.4
Weight (g)		
<500	34	16.0
500-999.99	54	25.5
1,000-1,499.99	27	12.7
1,500 – 2,499.99	55	25.9
2,500+	42	19.8
Time of life (minutes)		
Up to 60	190	89.6
61 - 1440	19	9
1441 - 2880	1	0.5
2881+	1	0.5
Not informed	1	0.5
Total	212	100

Source: study data, 2022.

Key: N: number; %: proportion; AMREC: Association of Municipalities of the Carboniferous Region; AMUREL: Association of Municipalities of the Laguna Region.

Table 2. Perinatal death: causes of death listed in the coroner reports from Criciúma and Tubarão between 2018 and 2022.

Variables	N	%
Immediate cause of death		
Complications of the placenta, cord, and membranes		
Acute respiratory failure	155	
Extreme immaturity	73.1	
Intrauterine hypoxia	14	6.6
Other causes	10	4.7
Intermediate cause of death 1	6	2.8
Extreme immaturity	27	12.8
Prematurity	5	2.4
Premature rupture of membranes	4	1.9
Pre-eclampsia	3	1.4
Other causes	12	5.7
Not informed	179	84.4
Significant conditions that contributed to death		
Type 2 diabetes mellitus	1	0.5
Multiple malformations	1	0.5
Congenital malformation of the cardiac septa	1	0.5
Not informed	209	98.6
Total	212	100

Source: study data, 2022.

Key: N: number; %: proportion.

and 96 (45.3%) were listed as providers of domestic services, including the following occupations: domestic worker, day laborer, general services, ironer, and laundry assistant. Information regarding maternal socioeconomic status is presented in detail in Table 3.

Regarding pregnancy and maternal obstetric history, most pregnancies were singletons, 195 (92%), with vaginal delivery being the predominant type, with 139 (65.6%) cases, as shown in Table 4. The mean gestational age was 30.29 weeks (SD = 5.687), ranging from 22 to 41 weeks. Eighty-nine (42%) mothers had no live births, and 149 (70.3%) had no miscarriages. A total of 190 (89.6%) pregnant women underwent prenatal follow-up, of which 50 (23.6%) went to one to three visits, 80 (37.8%) went to four to six visits, and 43 (19.3%) went to seven or more visits. Twenty-six (12.3%) reports did not contain information about prenatal care.

DISCUSSION

The analysis of the socio-demographic data included in this study revealed a higher number of deaths involving female individuals (51.4%) and whites (87.7%). The predominance of white individuals is likely due to the European ancestry of the majority of the inhabitants of the state of Santa Catarina.

As reported by Nobrega et al¹⁴. and Serra et al¹⁵, 85% of the records included in our study described the deaths of

Table 3. Perinatal death: socioeconomic data of mothers of deceased children with records at the coroner's office of Criciúma and Tubarão between 2018 and 2022

Variables	N	%
Age		
Up to 19 years	14	6,6
20 to 24 years	52	24,5
25 to 29 years	44	20,8
30 to 34 years	46	21,7
35 to 39 years	44	20,8
40+ years	12	5,7
Schooling		
No education	3	1,4
Elementary (1st to 4th grade)	12	5,7
Elementary II (5th to 8th grade)	50	23,6
High School	110	51,9
Incomplete higher education degree	7	3,3
Higher education degree	28	13,2
Did not answer		
Employment	2	1
Health	12	5,7
Clerical	19	9,0
Education	11	5,2
Tourism	17	8,0
Domestic services	96	45,3
Industry or agriculture	10	4,7
Fashion or retail	27	12,7
Self-employed	13	6,1
Student	6	2,8
Not informed	1	0,5
Total	212	100

Source: study data, 2022.

Key: N: number; %: proportion.

fetuses. However, Galen's hydrostatic test for infant live birth was negative in 73.6% of the cases. This difference may be related to the failure to perform the test during the autopsy or to an error in filling out the declaration of death^{14,15}. According to the Ministry of Health, fetal death is the death of a product of conception before expulsion or complete extraction from the mother's body, with a weight equal to or greater than 500 grams¹⁶. Most of the deaths included in our study were of individuals weighing 1000 grams or more, as also described by Nobrega et al. and Bezerra et al^{14,17}. Weight is an essential variable since low birth weight alone is considered a significant risk factor for infant mortality¹⁸. In 73.1% of the cases, death was attributed to complications of the placenta, cord, and membranes (ICD-10 P02), unlike what other authors found. In a study carried out in the city of Guarulhos¹⁹, intrauterine hypoxia and birth asphyxia were the leading causes of death.

Table 4. Perinatal death: factors related to the mothers and pregnancies of deceased children with records at the coroner's office of Criciúma and Tubarão between 2018 and 2022.

Variables	N	%
Number of live births		
0	89	42,0
1	63	29,7
2	38	17,9
3	11	5,2
4	5	2,4
5+	5	2,4
Not informed	1	0,5
Number of miscarriages		
0	149	70,3
1	40	18,9
2	18	8,5
3+	4	1,9
Not informed	1	0,5
Number of weeks		
22 to 26 weeks	72	34,0
27 to 31 weeks	45	21,2
32 to 36 weeks	55	25,9
37+ weeks	39	18,4
Not informed	1	0,5
Type of pregnancy		
Singleton	195	92,0
Twin	13	6,1
Triplet+	3	1,4
Not informed	1	0,5
Type of delivery		
Vaginal	139	65,6
Cesarean	73	34,4
Prenatal care		
Yes	190	89,6
No	13	6,1
Not informed	9	4,2
Total	212	100

Source: study data, 2022.

Key: N: number; %: proportion.

Another study conducted in the state of Espírito Santo¹⁷ listed maternal factors and complications of pregnancy, labor, and delivery as the most prevalent causes of death. It is important to emphasize that all such causes are preventable through interventions available in the Brazilian Unified Health System²⁰, underlining the importance of primary healthcare and adequate prenatal care and their role in positively affecting pregnancy outcomes.

Some fields were not filled out in the declarations of death of the individuals included in this study. The intermediate cause of death and significant conditions contributing to death were described in only 15.6% and 1.5% of the coroner's reports, respectively. The investigation of intrauterine deaths allows early intervention and the consideration of events linked to intrauterine death in future pregnancies²¹. This is why these fields in the coroner's report are paramount. Diseases that are common during pregnancy and increase the number of deaths, such as diabetes mellitus, preeclampsia, and syphilis, should be mentioned in these reports to improve the quality of epidemiological data and strengthen preventive interventions²².

Our results indicated that few deaths were related to external or internal malformations. Therefore, additional tests, such as pathological examination of the placenta and umbilical cord, were needed in 74.5% of the cases. The most prevalent findings were hemodynamic and metabolic disorders (46.7%), which may include hemorrhage, infarction, thrombosis, and vascular congestion. A retrospective study carried out in the city of Porto Alegre²¹ analyzing laboratory and pathological tests of the placenta and umbilical cord of stillbirths found a different reality. Most of the tests (39.6%) found infection linked to a high prevalence of pregnant women with a history of syphilis and other vaginal bacterial infections. In the same study, poor placental perfusion came in second place, with 37.9% of the tests indicating placental infarction²¹.

The average maternal age was 29.08 years. Most of the mothers completed high school (on average, they spent 11 years at school – 51.9%) and had a job in domestic services (45.3%). These findings were similar to the ones described in a study carried out in a capital city in the Brazilian Northeast¹⁵, in which the highest occurrence of perinatal deaths was in mothers with 9 to 11 years of schooling. Broday and Kluthcovsky (2022)²³ found a significant association between infant death and maternal years of schooling of up to seven years. Although low education was not evidenced in the present study, an association with functional illiteracy – the inability to apply knowledge in real-life contexts, thereby compromising the acquisition and comprehension of information – and its effects on adherence to prenatal care might be present²⁴. The majority of the women analyzed in our study had singleton pregnancies (92%), with an average duration of 30.29 weeks and vaginal delivery (65.6%). The analysis of maternal characteristics and perinatal outcomes performed by Brito et al.²⁵ described similar findings. Although multiple pregnancies are an essential risk factor for perinatal death²³, they are relatively uncommon. In the same study, 78% of deliveries were by cesarean section, an illustration of reality in the second country in the world in c-sections²⁵, although the same was not found in our study. A possible explanation is that the study investigated cases of fetal death, and vaginal delivery is the route with fewer complications.

Obstetric history is another important factor when evaluating perinatal outcomes. According to the analyzed coroner's reports, most of the women were nulliparous (42%) and had not had a previous miscarriage (70.3%). In the study conducted in the Brazilian Northeast¹⁵, 71.95% of the women had no previous miscarriages, as also found in our study, and 51.85% had a history of two to four live births, unlike ours. A survey conducted in the city of Vitória²⁶ assessed adverse perinatal outcomes and concluded that the chances of having a complicated pregnancy increased with the number of pregnancies. This divergence in the population analyzed may be associated with family planning, with a consequent reduction in the number of children per woman and pregnancies at a later age.

Most women analyzed in our study (89.6%) attended prenatal care visits, with four to six visits prevailing (37.8%). The Ministry of Health recommends that pregnant women attend at least six prenatal care visits: one in the first trimester, two in the second, and three in the third.²² Since the average number of weeks of gestation in our population was 30.29 weeks, corresponding to the beginning of the third trimester, our population complied with the recommendations of the Ministry of Health. This is an important finding. In the meta-analysis conducted by Wondemagegn et al.²⁷, adequate prenatal care correlated with a significant reduction in perinatal mortality. Prenatal care visits allow the dissemination of important information and the early identification of gestational and fetal conditions, which directly affect the chances of perinatal death²⁸. The data presented in our study outlined the sociodemographic profile of children who died in the perinatal period. It consisted of white female individuals weighing 1,000 grams or more. Fetal deaths accounted for the majority of the cases, with the most prevalent cause of death being ICD-10 code P02. Additional pathological examination showed the presence of hemodynamic and metabolic disorders. The average maternal age was 29.08 years, and most mothers completed high school and had a job in domestic services. Most underwent prenatal care, attended four to six visits, had a singleton pregnancy, vaginal delivery, and were pregnant for an average of 30.29 weeks.

It is important to emphasize that perinatal mortality is a crucial indicator for assessing prenatal care and factors related to mothers and pregnancies. These numbers substantiate the development of public health initiatives and measures. Therefore, correctly completing the coroner's report is essential to providing consistent epidemiological information, optimizing the allocation of resources, and reducing perinatal complications.

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