

## Infant Mortality in Novo Hamburgo: Associated Factors and Cardiovascular Causes

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### Abstract

**Background:** Infant mortality has decreased in Brazil, but remains high as compared to that of other developing countries. In 2010, the Rio Grande do Sul state had the lowest infant mortality rate in Brazil. However, the municipality of Novo Hamburgo had the highest infant mortality rate in the Porto Alegre metropolitan region.

**Objectives:** To describe the causes of infant mortality in the municipality of Novo Hamburgo from 2007 to 2010, identifying which causes were related to heart diseases and if they were diagnosed in the prenatal period, and to assess the access to healthcare services.

**Methods:** This study assessed infants of the municipality of Novo Hamburgo, who died, and whose data were collected from the infant death investigation records.

**Results:** Of the 157 deaths in that period, 35.3% were reducible through diagnosis and early treatment, 25% were reducible through partnership with other sectors, 19.2% were non-preventable, 11.5% were reducible by means of appropriate pregnancy monitoring, 5.1% were reducible through appropriate delivery care, and 3.8% were ill defined. The major cause of death related to heart disease (13.4%), which was significantly associated with the variables 'age at death', 'gestational age' and 'birth weight'. Regarding access to healthcare services, 60.9% of the pregnant women had a maximum of six prenatal visits.

**Conclusion:** It is mandatory to enhance prenatal care and newborn care at hospitals and basic healthcare units to prevent infant mortality. (Arq Bras Cardiol. 2015; 104(4):257-265)

**Keywords:** Infant Mortality; Perinatal Mortality / epidemiology; Fetal Death / epidemiology; Heart Diseases / epidemiology; Midwifery; Maternal and Child Health.

### Introduction

Infant mortality in Brazil has decreased over the past few decades, but remains high as compared to that of other developing countries<sup>1</sup>. In 2010, that rate was 19.88/1000 live births. In that same year, the Rio Grande do Sul state had the lowest infant mortality rate in Brazil (11.2 deaths/1000 live births)<sup>2</sup>, while the municipality of Novo Hamburgo, in the Porto Alegre metropolitan region, had the highest infant mortality rate in that region (14.2 deaths/1000 live births)<sup>3,4</sup> (Figure 1).

The major causes of neonatal mortality in Brazil are intrauterine and intrapartum asphyxia and low birth weight/prematurity. Conversely, in developed countries, those causes are extreme prematurity and congenital malformation<sup>5</sup>.

Similar to early neonatal mortality, high late neonatal mortality relates to poor maternal health conditions and unsatisfactory prenatal, delivery and newborn care<sup>6</sup>.

Because of the reduction in preventable causes, which result from social determinants, there is an increasing need to study congenital malformations, of which, heart diseases have the greatest impact.

This study was aimed at: describing the causes of infant mortality in the municipality of Novo Hamburgo, Rio Grande do Sul state, from 2007 to 2010; identifying the causes of death related to heart diseases and if they were diagnosed in the prenatal period; and assessing the access to healthcare services of the cases of infant death in the municipality of Novo Hamburgo.

### Methods

This is a population-based case study (deaths). From 2010 to 2011, data of the municipality of Novo Hamburgo were collected from the 2007-2010 infant death investigation records and from the Infant Mortality System by the same highly skilled researcher. This study sample comprised 157 infant deaths.

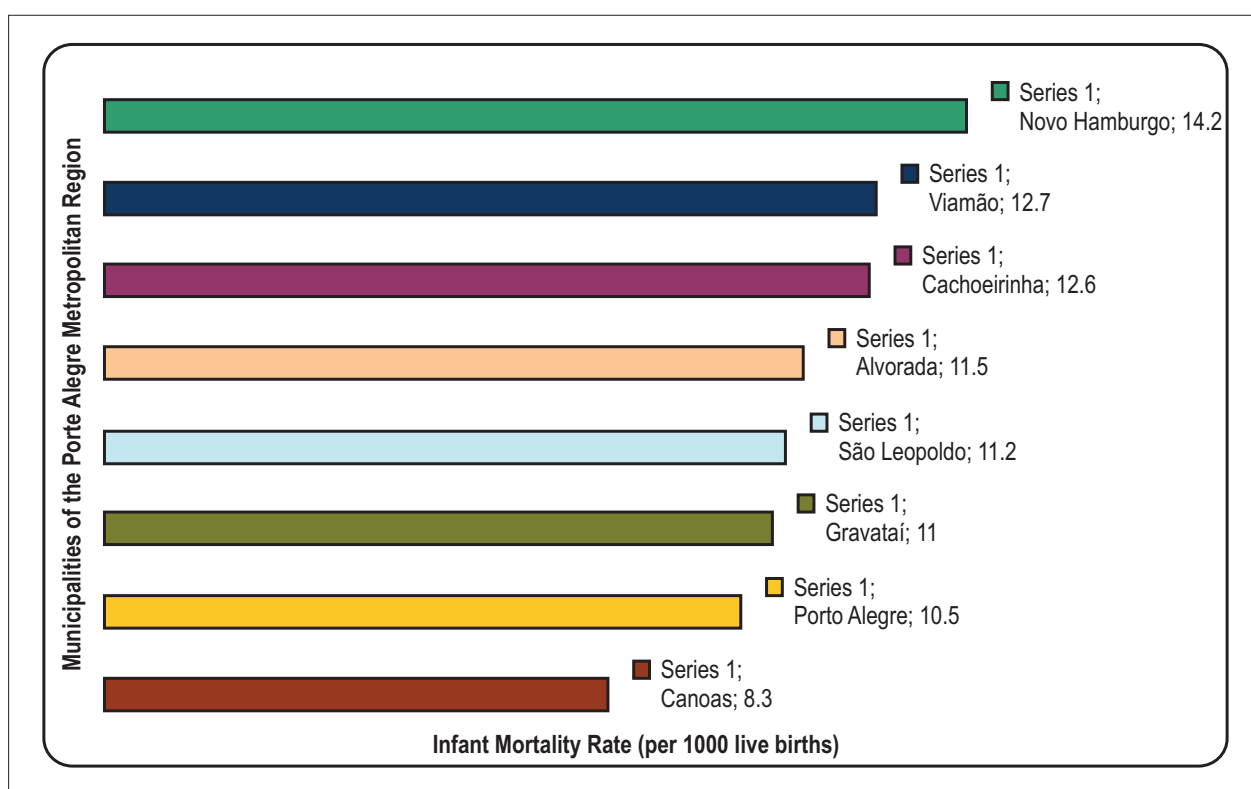
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**Figure 1** – Comparison of infant mortality in the Porto Alegre metropolitan region in 2010. Source: Health Secretariat of Rio Grande do Sul State.

This study included data of infants in the municipality of Novo Hamburgo, who died. Variables not found in the infant death investigation records were excluded.

The number of live births was obtained from the Live Birth Information System of the Health Secretariat of Rio Grande do Sul State (Sinasc). Birth and death dates and causes of death were collected from death certificates by the researcher responsible for the infant death investigation, as were the variables ‘gestational age’, ‘birth weight’ and ‘number of prenatal visits’, obtained from the hospital medical records of the newborn or from the maternal medical records.

The infant death investigation records are completed by a health professional (nurse or doctor), who investigates death based on the infant’s medical records, the maternal medical records and interviews with family members during home visits.

The causes of death were classified according to the Classification of the São Paulo State Data Analysis System (Seade) Foundation, which is used by the Brazilian Ministry of Health to classify the causes de death aiming at prevention. Heart diseases are classified as preventable causes, which can be reduced through early management interventions.

For categorical variables, descriptive analysis (percentage) was used, and, for continuous variables, mean and standard deviation. The chi-square test and analysis of residues were used. The 5% significance level was adopted. The SPSS software, version 19, was used for data analysis.

This study used secondary data, was approved by the Committee on Ethics and Research of the Institute of Cardiology of Rio Grande do Sul, and no written informed consent was required.

## Results

Of the 157 deaths in the 2007-2010 period, 44.6% occurred in the early neonatal period, 22.3% in the late neonatal period, and 33.1% in the postneonatal period. According to the Seade Foundation Classification, the major causes of infant death in Novo Hamburgo (35.3%) could be reduced through actions of diagnosis, prevention and early treatment; 25% were reducible by use of partnership with other sectors; and 19.2% were non-preventable (Figure 2). Regarding birth sites, 77.4% of the births occurred at hospitals of the Novo Hamburgo municipality, and 21.3% at hospitals of other municipalities. Regarding the infants who died, 57.2% were males and 64.1% had a birth weight lower than 2,500 g.

Regarding maternal characteristics, most women whose infants died were younger than 35 years (84.6%), and 39.7% of them had a gestational age higher than 36 weeks. Considering access to healthcare services, 39.2% of the pregnant women had at least six prenatal visits (Table 1).

Heart diseases were the major cause of infant death (13.4%), followed by respiratory distress syndrome of the newborn (8.9%) and unspecified bacterial septicemia of the newborn (8.3%). The causes of mortality related to heart

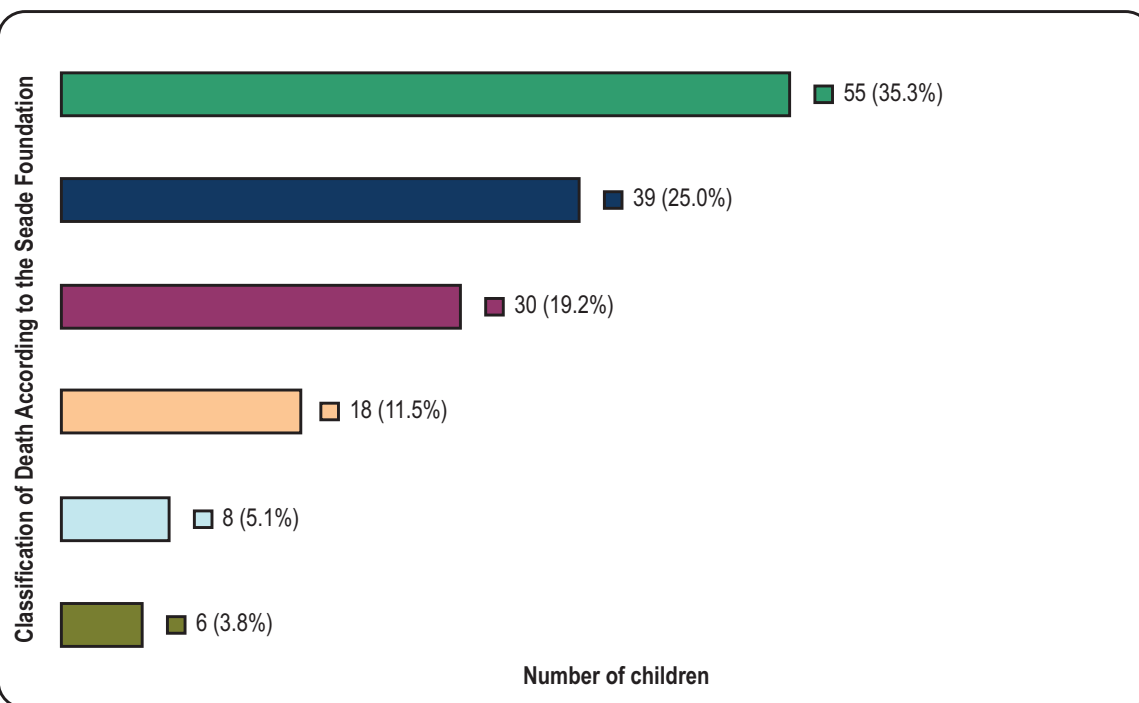


Figure 2 – Causes of infant mortality in the municipality of Novo Hamburgo in 2007-2010 according to the Seade Foundation.

diseases in death certificates were: unspecified cardiac malformations (7.6%); malformations related to Edwards syndrome (1.3%); unspecified malformation of the chambers and septal defects (0.6%); unspecified malformation of the great vein (0.6%); coarctation of the aorta (0.6%); congenital mitral stenosis (0.6%); common arterial trunk (0.6%); pulmonary valve atresia (0.6%); and hypoplastic left heart syndrome (0.6%). Most of the deaths related to heart diseases occurred in the postneonatal period (61.9%).

There was a statistically significant association between heart disease and the variables 'age at death', 'gestational age' and 'birth weight'. A statistically significant association was observed between the cause of death and the following variables studied: 'age at death' ( $p = 0.043$ ), with 23.1% of the postneonatal deaths related to cardiovascular causes; and 'gestational age' ( $p = 0.013$ ), 24.2% of those born after the 36th gestational week had a cardiovascular cause of death. Regarding the variable 'birth weight' ( $p = 0.015$ ), 96.2% of the extremely low birth weight infants (<1,000 g) showed an association with death due to other causes, and 26.7% of those with birth weight between 1,500 and 2,499 g showed an association with death due to heart diseases (Table 2).

No heart disease was diagnosed prior to delivery, and no pregnant woman underwent echocardiography.

## Discussion

Reducing infant mortality is a major challenge in Brazil for health managers and professionals and the whole society<sup>7</sup>.

Although the number of deaths significantly decreased in the past decade, because of the reduction in postneonatal mortality in Brazil, most deaths occurred in the poorest regions, reflecting social inequities. That situation is even worse considering that most of those early deaths could have been prevented with timely access to quality healthcare services<sup>8</sup>.

According to *The Lancet – University of Oslo Commission on Global Governance for Health*, the objective of the policy for equity and health is not to eliminate all health differences so that everybody has the same health level and quality, but to reduce or eliminate those differences resulting from preventable and unfair factors<sup>9</sup>.

In the early neonatal period, the most common risk factors are prematurity, intrapartum asphyxia, neonatal infections and low birth weight<sup>10</sup>. The World Health Organization estimates that, in developed countries, approximately two thirds of low-birth-weight newborns are premature, while one third is small for gestational age<sup>11</sup>. That relationship is inverse in poor countries, where approximately 75% of low-birth-weight newborns are small for gestational age, and low birth weight is almost always strongly associated with conditions of poverty and maternal chronic poor nutrition and insufficient food consumption<sup>12</sup>.

This is the first study to assess the causes of infant death in a developed municipality of Rio Grande do Sul state, Novo Hamburgo, whose *per capita* Gross Domestic Product (GDP) in 2011 was R\$ 23,009.67, and whose Human Development Index (HDI) in 2010 was 0.747<sup>2</sup>. In the years 2007 to

**Table 1 – Characteristics of the sample**

Variables	n = 157
<b>Classification of age at death – n (%)</b>	
Early neonatal	70 (44.6)
Late neonatal	35 (22.3)
Postneonatal	52 (33.1)
<b>Infant sex – n (%)</b>	
Male	90 (57.3)
Female	67 (42.7)
<b>Birth site* – n (%)</b>	
Hospital of the NH municipality	120 (77.4)
Hospital of another municipality	33 (21.3)
Other (outside hospital)	2 (1.3)
<b>Gestation** – n (%)</b>	
Single	135 (87.7)
Double	19 (12.3)
<b>Delivery** – n (%)</b>	
Vaginal	81 (52.6)
Cesarean	73 (47.4)
<b>Maternal age*** – n (%)</b>	
< 35 years	132 (84.6)
≥ 35 years	24 (15.4)
<b>Income# – n (%)</b>	
None/up to 1 minimum wage	17 (18.9)
1-3 minimum wages	53 (58.9)
> 3 minimum wages	20 (22.2)
<b>Maternal schooling## – n (%)</b>	
Illiterate/1-3 years	15 (10.1)
4-8 years	86 (58.1)
> 8 years	47 (31.8)
<b>Gestational age*** (weeks) – n (%)</b>	
22-27	39 (25.0)
28-31	27 (17.3)
32-36	28 (17.9)
> 36	62 (39.7)
<b>Birth weight*** (grams) – n (%)</b>	
< 1,000 – extreme low weight	53 (34.0)
1,000-1,499 – very low weight	17 (10.9)
1,500-2,499 – low weight	30 (19.2)
≥ 2,500 – eutrophic	56 (35.9)
<b>Number of prenatal visits – n (%)</b>	
None	9 (6.3)
1-3	19 (13.3)
4-6	59 (41.3)
> 6	56 (39.2)

NH: Novo Hamburgo. \* Two infants (1.3%) without birth site registration; \*\* Three infants (1.9%) lacked that information; \*\*\* One mother (0.6%) lacked that information; # 67 registries (42.7%) lacked that information. ## Nine registries (5.7%) lacked that information.

**Table 2 – Association between cause of death and the variables studied**

Variables	n	Death due to CV causes	Death due to NCV causes	p*
		n (%)	n (%)	
<b>Classification of death</b>				<b>0.043</b>
Early neonatal	70	6 (8.6)	64 (91.4)	
Late neonatal	35	3 (8.6)	32 (91.4)	
Postneonatal	52	12 (23.1)**	40 (76.9)	
<b>Infant sex</b>				<b>0.827</b>
Male	90	13 (14.4)	77 (85.6)	
Female	67	8 (11.9)	59 (88.1)	
<b>Birth site</b>				<b>0.597</b>
Hospital of the NH municipality	120	15 (12.5)	105 (87.5)	
Hospital of another municipality	33	6 (18.2)	27 (81.8)	
Other (outside hospital)	2	0 (0.0)	2 (100)	
<b>Gestation</b>				<b>0.470</b>
Single	135	19 (14.1)	116 (85.9)	
Double	19	1 (5.3)	18 (94.7)	
<b>Delivery</b>				<b>0.625</b>
Vaginal	81	9 (11.1)	72 (88.9)	
Cesarean	73	11 (15.1)	62 (84.9)	
<b>Maternal age</b>				<b>0.744</b>
< 35 years	132	17 (12.9)	115 (87.1)	
≥ 35 years	24	4 (16.7)	20 (83.3)	
<b>Income</b>				<b>0.235</b>
None/up to 1 minimum wage	17	1 (5.9)	16 (94.1)	
1-3 minimum wages	53	4 (7.5)	49 (92.5)	
> 3 minimum wages	20	4 (20.0)	16 (80.0)	
<b>Maternal schooling</b>				<b>0.738</b>
Illiterate/1-3 years	15	1 (6.7)	14 (93.3)	
4-8 years	86	12 (14.0)	74 (86.0)	
> 8 years	47	6 (12.8)	41 (87.2)	
<b>Gestational age (weeks)</b>				<b>0.013</b>
22-27	39	2 (5.1)	37 (94.9)	
28-31	27	1 (3.7)	26 (96.3)	
32-36	28	3 (10.7)	25 (89.3)	
> 36	62	15 (24.2)**	47 (75.8)	
<b>Birth weight</b>				<b>0.015</b>
< 1,000 – extreme low-weight	53	2 (3.8)	51 (96.2)**	
1,000-1,499 – very low weight	17	1 (5.9)	16 (94.1)	
1,500-2,499 – low weight	30	8 (26.7)**	22 (73.3)	
≥ 2,500 – eutrophic	56	10 (17.9)	46 (82.1)	
<b>Number of prenatal visits</b>				<b>0.235</b>
None	9	0 (0.0)	9 (100)	
1-3	19	1 (5.3)	18 (94.7)	
4-6	59	6 (10.2)	53 (89.8)	
> 6	56	10 (17.9)	46 (82.1)	

CV: cardiovascular; NCV: non-cardiovascular; NH: Novo Hamburgo. \* Chi-square test. \*\* Statistically significant association according to the analysis of residues adjusted to 5% significance.

2010, 157 infants died, the infant mortality rate being 13.1 deaths/1000 live births. The present study found that the major cause of infant mortality was heart disease (13.4%), and almost half of the pregnant women had at least six prenatal visits.

The infant mortality rate in the municipality of Novo Hamburgo was 14.2/1000 live births in 2010, which is higher than the mean rate for the Rio Grande do Sul state, whose rates have decreased (Figure 3) due to the implementation of public health policies in the most needy municipalities<sup>13</sup>. In 2010, that state registered 11.2 deaths/1000 live births and a mean of 12 deaths/1000 live births in the period studied. The infant mortality in the municipality of Novo Hamburgo is low as compared to that of the municipalities of the Brazilian Northern and Northeastern regions, but, as compared to other similar municipalities of the Porto Alegre metropolitan region, it is high, indicating insufficiently organized primary healthcare and poor quality prenatal care. The interface between primary and secondary healthcare is inadequate, and many patients go to the municipality of Novo Hamburgo, because it is a reference center with neonatal intensive care units of the Brazilian Unified Healthcare System (SUS). In 2010, that municipality was changing its healthcare provision system, leaving the population with an insufficient number of basic healthcare units. From that year on, teams of Family Healthcare Strategy were implemented according to the needs of each neighborhood, and more healthcare units were built. The model of healthcare provided exclusively through basic healthcare units might not ensure the coverage of all pregnant women regarding prenatal visits, which can be facilitated in the presence of a family healthcare strategy. The family healthcare approach widens healthcare access and improves user's adherence, increasing the capacity to solve problems and the quality of the healthcare provided.

In Brazil, neonatal mortality has stabilized at elevated levels, with a small change in its early neonatal component, playing an important role in infant mortality<sup>14</sup>. This reflects the care provided to pregnant women and fetuses during the antepartum and delivery periods, and the immediate care provided to newborns at birth<sup>14</sup>. Novo Hamburgo follows that trend, with 66.9% of deaths in the neonatal period. In a study conducted in Porto Alegre between 2000 and 2003, Jobim and Aerts<sup>15</sup> have reported 56.9% of the deaths occurring in the neonatal period.

Most infant deaths in the period studied (35.3%) could have been reduced through prevention, diagnosis and early treatment actions. That is, they were caused by treatable diseases, such as diseases of the circulatory, respiratory, nervous and endocrine systems, whose treatment could be highly complex. Twenty-five percent of deaths were classified as reducible by means of partnerships with other sectors and could have been prevented by expanding basic sanitation, educational measures (related to AIDS), and prevention of accidents, violence and malnutrition. Non-preventable deaths corresponded to 19.2% of the total and were related to either congenital malformations incompatible with life or birth weight lower than 1,000 g. Adequate pregnancy monitoring could have reduced 11.5% of the deaths, and adequate delivery care, 5.1%<sup>16,17</sup>. In a study performed in the Brazilian Federal District in 1999

and 2000, classifying death according to preventability, Monteiro and Schmitz<sup>18</sup> have reported a similar result, with 35.5% of deaths being reducible by means of prevention, diagnosis and early treatment actions<sup>18</sup>. In a study carried out from 2000 to 2003 in the city of Porto Alegre, where 1,139 deaths occurred, Jobim and Aerts<sup>15</sup> reported that 76.6% were classified as preventable.

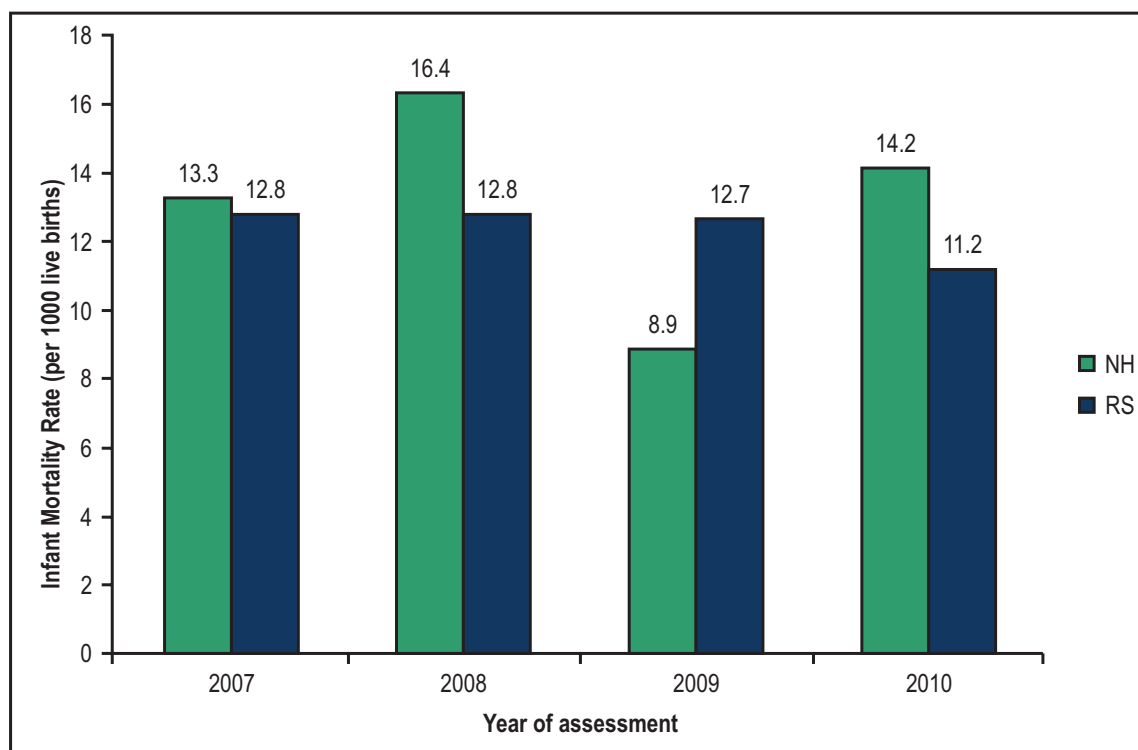
The present study found that 77% of the deaths were considered preventable. A study conducted in the city of Londrina, Paraná state, has assessed two birth cohorts and found that 71.6% of the infant deaths of the 2000-2001 cohort and 65.5% of those of the 2007-2008 cohort were considered preventable<sup>19</sup>. Another study, carried out in the city of Recife, Pernambuco state, has reported that, from 2000 to 2009, 76.4% of the infant deaths could have been prevented<sup>20</sup>. Preventable deaths are those that can be reduced through effective actions of health services. They are also considered sentinel events of healthcare quality, their presence indicating a flaw in healthcare. The classification of deaths as preventable is aimed at: monitoring and assessing healthcare services; analyzing temporal trends; comparing indicators between regions; and planning measures for their reduction<sup>20</sup>.

This study showed that 60.9% of pregnant women had a maximum of six prenatal visits, only 39.2% had more than six prenatal visits, and the infants who died due to heart diseases had not been prenatally diagnosed. It is worth noting that, even with prenatal care and obstetrical echography, the prenatal detection rate of heart disease is very low<sup>21</sup>.

In the study by Soares and Menezes<sup>7</sup>, the number of prenatal visits had a protective effect against early infant mortality. The newborn, whose mother had none or only one to three prenatal visits, had a four-fold increased risk of dying than that whose mother had at least six prenatal visits. In the present study, 60.9% of the pregnant women had a maximum of six prenatal visits, and most of them (41.3%) had four to six visits. Several studies have shown the importance of prenatal care to prevent neonatal morbidity and mortality<sup>22,23</sup>. Although infant mortality in Brazil has significantly decreased in past decades, the velocity of neonatal death reduction is lower than desired. A significant number of deaths is still part of the Brazilian social and sanitary reality, being due to preventable causes, mainly related to healthcare actions, such as prenatal, delivery and newborn care. The Brazilian Ministry of Health recommends at least six prenatal visits<sup>24</sup>.

The present study identified that 13.4% of the deaths were due to cardiovascular causes, corresponding to an incidence of 1.8 death/1000 live births. There is agreement between that and the incidence reported by several studies with specific populations (2-10/1000 live births)<sup>25</sup>. However, a study conducted in the Rio Grande do Sul state, screening 3,980 fetuses by use of echography at a reference service from 1996 to 2000, has reported an incidence of 25.8/1000<sup>26</sup>. Another study, performed at a maternity in the Minas Gerais state from 1990 to 2003, has analyzed a data bank with 29,770 deaths and found a heart disease prevalence of 37.2% of live newborns and of 18.7% of stillbirths<sup>27</sup>.





**Figure 3** – Comparison of infant mortality in the Rio Grande do Sul state (RS) and municipality of Novo Hamburgo (NH) in 2007-2010. Source: Health Secretariat of Rio Grande do Sul State.

When analyzing data regarding deaths due to heart diseases and the variables studied, 23.1% of the infants died in the postneonatal period, which might represent a low diagnosis rate of those diseases, which were neither detected during prenatal care nor diagnosed and treated at birth. The gestation of 24.2% of the infants dying due to heart diseases lasted more than 36 weeks, and the birth weight of 26.7% of them was 1500-2499 g. These data evidence that they had neither extremely low birth weight nor extreme prematurity. If diagnosed at an early phase, they could have been referred to a specialized service and properly treated, preventing some deaths.

Regarding the limitations of this study, it is worth noting the lack of information in the infant death investigation records (incomplete medical records, family not found) of some cases. For infants born in other municipalities, not all information on death could be obtained, because the Mortality Information System is centralized in the Brazilian Ministry of Health and not provided to the municipalities. Regarding prenatal care, the infant death investigation records provided the number of prenatal visits, but not the gestational trimester of the visit, which limits prenatal care assessment. In addition, infant death investigation records classified the number of prenatal visits as 'four to six' or 'more than six', hindering the description of the exact number of visits. Such limitations do not invalidate the results of this study, which are in accordance with the literature.

## Conclusion

Heart diseases were the major cause of infant mortality in this study. The risk factors related to infant mortality and the circumstances under which the deaths occur need to be known. Thus, better planning of healthcare actions specific for local realities will be possible, resulting in a decrease in childhood mortality rates. By reducing preventable deaths, the early identification of complex situations, such as heart diseases, is increasingly needed.

Although the Brazilian Ministry of Health recommends at least six prenatal visits, 60.9% of the pregnant women in this study had a maximum of six visits, which did not prevent infant death. Auditing is thus required to assess the quality of prenatal care at basic healthcare units, as well as planning strategies to facilitate the access of pregnant women to healthcare services.

Based on the fact that the major causes of infant death in the municipality of Novo Hamburgo could have been reduced by means of actions of diagnosis, prevention and early treatment, it is mandatory to enhance prenatal care, newborn care at hospitals and at basic healthcare units, and to ensure the availability of tests to assess the fetal heart at prenatal visits to avoid deaths due to cardiovascular diseases.

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## Author contributions

Conception and design of the research: Pellanda LC, Stein AT. Acquisition of data: Brum CA. Analysis and interpretation of the data: Brum CA, Pellanda LC, Stein AT. Statistical analysis: Brum CA, Pellanda LC, Stein AT. Writing of the manuscript: Brum CA, Pellanda LC, Stein AT. Critical revision of the manuscript for intellectual content: Brum CA, Pellanda LC, Stein AT.

## Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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## Study Association

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