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Avoidable deaths until months of age among children from the 2004 Pelotas birth cohort

ABSTRACT

OBJECTIVE: To describe avoidable of children from the 2004 Pelotas Birth Cohort.

METHODS: The death of 92 children between 2004/2008 from Pelotas Birth Cohort were identified and classified according to the Brazilian List of Avoidable Causes of Mortality of Brazilian Unified Healthcare System. The Mortality Information System (SIM) for the State of Rio Grande do Sul (Southern Brazil) and the city of Pelotas were screened to search for deaths that occurred outside the city, as well as causes of deaths after the 1st year. Causes of infant deaths (<1 year of age) were compared between information from a sub-study and SIM. Mortality coefficients per 1,000 LB and proportional mortality for avoidable causes, including by type of health facility (traditional or Family Health Strategy) were calculated.

RESULTS: The mortality coefficient was 22.2/ 1,000 LB, 82 the deaths occurred in the first year of life (19.4/1,000LB), and these included 37 (45%) in the first week. More than ¾ of the deaths (70/92) were avoidable. In infancy, according to the sub-study, the majority (42/82) could be prevented through adequate care of the woman during pregnancy; according to SIM, the majority could have been prevented through adequate newborn care (32/82). There was no difference in the proportion of avoidable deaths by type of health facility.

CONCLUSIONS: The proportion of avoidable deaths is high. The quality of death certificate registries needs improvement so that avoidable deaths can be employed as an indicator to monitor maternal and child health care.

DESCRIPTORS: Infant Mortality. Child Mortality. Cause of Death. Cohort Studies.

INTRODUCTION

Infant mortality includes deaths between birth and the first year of life.[22] It is an important indicator for the level of economic development in a community.[24]

Preliminary data showed that, between 1994 and 2008, infant mortality in Brazil reduced from 38.2 to 19.0 per thousand live births (LB),[a] mostly due to the reduction in postneonatal deaths, which was responsible for the largest proportion of infant mortality in the country. Despite the decrease, infant mortality continues to be an important public health problem in Brazil: there were 90 thousand deaths among infants under one year old in 2004, the majority from avoidable causes.[b] Avoidable deaths are those that could have been prevented

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[a] Ministério da Saúde. Saúde Brasil 2009: uma análise da situação de saúde e da agenda nacional e internacional de prioridades em saúde. Brasília, DF; 2010. [Cited 2010 Dez 21]. Available from: http://portal.saude.gov.br/portal/arquivos/pdf/SAUDE_BRASIL_2009_COLETIVA.pdf

[b] UNICEF. Retrato estatístico dos direitos da criança e do adolescente. Brasília, DF; 2006.

(in totality or in part) with the presence of effective health services.[20]

In critique of the various mortality analyses performed among the three Pelotas Birth Cohorts (1982, 1992 and 2004),[11,18,22] no study specifically analyzed the percentage of deaths classified as avoidable. The identification and quantification of these causes are important for directing health actions, since decisions in regards to investment of human and technological resources depend on understanding the mechanisms that leads to death. This study aimed to describe avoidable deaths among children born in the 2004 Pelotas Cohort.

METHODS

Pelotas is located in the far South of Brazil, close to the border with Uruguay and Argentina and has a population of 340,000 residents. It is a transportation and university center and a reference point in the health sector for the Southern region of Rio Grande do Sul, according to the Regionalization Director Plan.[c] The Sistema Único de Saúde (SUS – National Unified Health System) in Pelotas consists of 54 Unidade Básica de Saúde (UBS – Basic Health Units) distributed in urban and rural zones. The 4,231 LB in Pelotas were included in the 2004 Birth Cohort. To identify births, hospitals were visited daily, from January 1 to December 31, by a specially trained team. Mothers that resided in the urban zone of Pelotas and in the Jardim América neighborhood (contiguous to Pelotas and part of the city of Capão do Leão) were interviewed immediately after birth with a pre-coded questionnaire. Children were weighed and measured.[3] The cohort of children were followed-up four times: at three, 12, 24 and 48 months of age. Further details on the methodology of the 2004 Cohort are available elsewhere.[2]

Deaths were identified through follow-up visits and searches of the SIM-RS and SIM-Pelotas database, through 31 December 2008, when all children had completed four years of age. The data was transferred to an electronic worksheet, and the mother's name and child's date of birth (date and month) were compared to the available information in the perinatal cohort database. The information available in SIM was transcribed, and the primary cause of death from the death certificate was assumed to be the actual cause of death.

Deaths during the first year of life were analyzed (between 1 Januray 2004 and 31 December 2005). Deaths were monitored by daily visits to the main hospitals of the city (intensive care units, nurseries, pediatric infirmaries and emergency rooms). To detect extra-hospital deaths, bureaucratic registration offices, cemeteries and Regional Health Delegacies were visited. Early neonatal deaths (occurring in the first seven days), late neonatal deaths (from the eighth until before the 28th day) and postneonatal deaths (from 28 until 364 days) were included. Information about the primary cause of death were collected by interview of the pediatrician responsible for the newborn's care at the time of death. In the case of hospitalized children, hospital records were reviewed, and information about the cause of admission, patient history, illness progression, complementary tests, treatment and diagnosis were gathered. Information collected from the perinatal questionnaire of the mother were utilized if necessary.

For children that died between seven and 364 days, a household visit was performed to ask the mother about the clinical history of the illness and its antecedents. For this interview, the questionnaires from the Inter-American Investigation of Mortality in Childhood[d] were adapted to the local reality. These questionnaires comprise several sets of questions, including: identification data, maternal complications, information about type of birth, type of transport for the newborn to the neonatal treatment unit, the newborn's conditions when admitted into an intensive care unit, pathologies identified, treatment and start and progression of symptoms. For deaths that occurred outside of the hospital or in other cities, information was collected from death certificates, supplemented by household interviews with family members. Two independent pediatricians were responsible for determining the primary cause of death. In case of disagreement, a third pediatrician was invited to discuss the case for a final decision. The decisions were codified according to the International Classification of Diseases.[e] For those that died after the first year of life or that were not found in follow-up visits, the cause of death was obtained through an analysis of SIM-RS and SIM-Pelotas databases.

Deaths of children less than five years of age were considered avoidable through primary care actions as proposed by Malta et al.[15] The list is divided into three sections: avoidable deaths, deaths from undefined causes and other causes. The avoidable causes of death were classified in four groups: preventable through immunization; adequate care for women during pregnancy and birth and newborn care; adequate diagnostic and treatment actions; and adequate health promotion actions connected to adequate health care actions.

The deaths avoidable through adequate maternal care during pregnancy and birth and adequate newborn care are divided into avoidable by: adequate maternal care

[c] Estado do Rio Grande do Sul. Secretaria da Saúde. Plano Diretor de Regionalização da Saúde. Porto Alegre; 2002.
[d] Puffer RR, Serrano CV. Patterns of mortality in childhood: report of the Inter-American Investigation of Mortality in Childhood. Washington, DC: Pan American Health Organization; 1973.
[e] World Health Organization. International statistical classification of diseases and related health problems: 10. revision. Geneva; 1993.

during pregnancy (congenital syphilis; diseases caused by HIV; maternal conditions that affect the fetus or newborn, which are transmitted through the placenta or mother's milk and are not necessarily related to the current pregnancy; maternal pregnancy complications that affect the fetus or newborn, fetal growth or fetal malnutrition; conditions related to short-term gestations and low birth weight); adequate maternal care during birth (other complications of delivery that affect the newborn, conditions related to long gestations and high birth weight, trauma from birth, intrauterine hypoxia and birth asphyxia and neonatal aspiration); and adequate newborn care (congenital pneumonia, newborn respiratory difficulty, pulmonary hemorrhage originating from the perinatal period, bacterial septicemia and omphalitus).

Children under one year old were classified as cases of sudden infant death syndrome (SIDS) when there was a death at home without an apparent cause (the mother found the dead child in the crib, without identifying any previous disease symptom), a death with a determination of "death by milk aspiration" or "death by suffocation" or when there was no autopsy for death and an unknown ICD cause. Although the list by Malta et al[15] classified sudden death as "other causes", we classified sudden death as reducible through adequate health promotion actions, since putting children to sleep on their back is an effective prevention measure.[14]

Prematurity was classified as a primary cause as long as there was no associated illness, such as syphilis or congenital malformations.

The perinatal database from the 2004 cohort provided information gathered at birth (name; sex; date of birth; birth weight; gestational age,[16] utilizing the date of last menstruation and newborn exam, according to the method by Dubowitz[6]) and household address. For those that died, the date, age and municipality of residence at time of death were obtained from the cohort follow-up registry or from the SIM database.

Between 2004 and 2008, the local health system was characterized according to the following features of the UBS: name, address, geographic area of the enrolled population, type of health facility (traditional of Estratégia de Saúde da Família – ESF; Family Health Strategy). The day of initiation for the ESF team was utilized to classify the health unit as ESF if it functioned for at least six months (before January 2004). The mixed health posts (traditional with ESF team) were classified as ESF, irrespective of the number of teams. The central region of Pelotas, which has one UBS and a large amount of low-income households in its enrollment area that lack basic health services, was analyzed separately.

To calculate the mortality rate, the number of child deaths in the cohort through 2008 was divided by the total number of LB (4,231) and multiplied by 1,000. The mortality rate from avoidable causes was obtained by dividing number of deaths due to avoidable causes by total LB and multiplying the result by 1,000. Proportionate mortality from avoidable causes was calculated by dividing number of deaths from avoidable causes by total number of deaths and multiplying by 100. These indicators were calculated for total deaths and for infant deaths. Proportionate mortality rate was calculated separately according to the type of health care facility (traditional or ESF) based on the address provided by the mother after birth in order to identify and classify the UBS responsible for the child care.

The research project of the 2004 Pelotas Birth Cohort was approved by the Research Ethics Committee of the Faculdade de Medicina da Universidade Federal de Pelotas (OF 080/09 of 25 March 2009).

RESULTS

There were 94 deaths, 82 before the first full year of life, which corresponds to an infant mortality coefficient of 19.4 deaths per 1,000 LB. The majority of deaths occurred in the early neonatal period (45.1%, n=37), followed by late neonatal deaths (18.3%, n=15) and postneonatal (36.6%, n=30). Twenty-six children weighed less than 1,000 grams at birth, 17 of which weighed less than 800 grams (three of these survived the first week of life). Twelve children died after the first year of life, an overall death rate of 22.2 per 1,000 LB in the 2004 cohort.

Of the 82 deaths during the first year of life, 65 had avoidable causes (Table 1). The most frequent causes of death in the first year of life were the conditions related to early-term pregnancy and low birth weight (Table 2). The majority of avoidable deaths could be reduced by adequate maternal care (63.1%; 41/65) (Table 1). Early-term pregnancy was present in 47.6% of deaths (39/82) (Table 2), and among these, 28 children had respiratory distress syndrome, a complication of early-term pregnancy. The cause of death was identified as SIDS in four children and congenital syphilis in two.

In two of 12 deaths after one year old, it was not possible to identify cause. They were lost to follow-up, and the deaths probably occurred outside of the state, since the name of the children and their mothers were not identified in SIM-RS. Four of ten deaths were identified as avoidable: two through adequate diagnosis and treatment (bronchopneumonia and acute myocarditis) and two through adequate health promotion actions (both from traffic accidents) (Tables 1 and 2).

The mortality rate from avoidable causes for children between zero and 48 months of age was 16.5 per 1,000 LB). Most deaths were avoidable (76.1%, 70/92) and

Table 1. Number of deaths until 48 months by age period, according to the list of avoidable deaths. Pelotas, Southern Brazil, 2004-2008. (n = 92)

Period of death		Avoidable causes							Undefined	Other causes
		A	B			C	D	Sub-total		
			B1	B2	B3					
< 1 year (n = 82)	Early neonatal (n = 37)	-	26	4	1	-	-	31	-	6
	Late neonatal (n = 15)	-	10	-	2	1	1	14	-	1
	Postneonatal (n = 30)	-	5	-	-	9	6	20	4	6
	All < 1 year (n = 82)	-	41	4	3	10	7	65	4	13
12 to 48 months (n = 10)		-	1	-	-	2	2	5	-	5
All < 48 months (n = 92)		-	42	4	3	12	9	70	4	18

A: Reducible through immunization.
B: Reducible through adequate maternal care during pregnancy and birth and newborn care.
B1: Reducible through adequate maternal care during pregnancy.
B2: Reducible through adequate maternal care during birth.
B3: Reducible through adequate newborn care.
C: Reducible through adequate diagnosis and treatment.
D: Reducible through adequate health promotion connected to adequate health care.

could have been reduced, mainly through adequate maternal care during pregnancy and birth and newborn care (70.0%, 49/70) (Table 1). Adequate maternal care during pregnancy could avoid 60.0% of avoidable deaths (42/70) and 85.7% (42/49) of deaths from this group of causes. No deaths occurred from causes of death avoidable by immunization.

Comparison, of the primary cause of death during the first year of life to causes available in SIM, showed that to both the principal causes of deaths were preventable through adequate maternal care during pregnancy and birth and newborn care. There was a discrepancy between the two sources: while in this study avoidable causes of infant death were mostly reducible with adequate maternal care during pregnancy, according to SIM adequate newborn care was most important (Figure 1).

The majority of births in the 2004 cohort were children whose families resided outside of the city's central zone. More than half of births occurred in about half of the areas belonging to city's UBS.

There was no information for mother's residence in three of the 94 children in the cohort, and it was not possible to link them to any UBS. Ten deaths were in children that lived in the city's central area. For all other deaths, Table 3 presents number of births in 2004, number of deaths in the first year of life and until 48 months of age and number of avoidable deaths, by type of UBS.

There were 2,523 LB in the enrollment areas of traditional UBS, of which 51 died, corresponding to a mortality rate of 20 per 1,000 LB during the period. Of these deaths, approximately ¾ (n = 38) were avoidable, and more than half (n = 23) avoidable through adequate maternal care during pregnancy.

There was no statistically significant difference in incidence of avoidable deaths between the type of UBS for place of birth (p = 0.8) (Table 3). There were 1,200 births registered in enrollment areas of the UBS-ESF. Thirty children died, which represents a mortality rate of 25 per 1,000 LB, similar to traditional UBS (p = 0.36). Of these deaths, 80% (n = 4) were avoidable and half (n = 15) were avoidable through adequate care for pregnant women. In total, 1.5% of children born in traditional UBS areas (38/2,523) died from some type of avoidable cause. The corresponding proportion for births in ESF areas was 2.0% (24/1,200), and in the central area it was 1.4% (7/503).

DISCUSSION

Mortality among children less than five years old in the 2004 Pelotas Cohort was concentrated in the first year of life. The majority of deaths could be avoided, mainly through adequate care to pregnant women. This finding is consistent with the increase in premature births registered in the city during the last decades.[4] In 1982, prevalence of pre-term births was 6.3%, increasing to 11.4% in 1993 and 14.7% in 2004.[4] During this period, infant mortality, which in Pelotas decreased between 1982 and 1993 (from 36.4 to 21.1 per 1,000 LB), remained stable between 1993 and 2004 (19.4 per 1,000 LB).[23] The increase in pre-maturity was the main cause of death identified in the perinatal period and the first year of life.[17]

[f] Taucher E. Mortalidad infantil en Chile: tendencias, diferenciales y causas. Santiago de Chile: Centro Latinoamericano de Demografia; 1979.

Table 2. Causes of child death according to the list of avoidable deaths. Pelotas, Southern Brazil, 2008. (n = 92).

Classification	Cause of death	Deaths < 1 year n	Deaths 12-48 months n
B1	Congenital syphilis	2	1
	Conditions related to short gestation and low birth weight not classified elsewhere	39	-
B2	Neonatal aspiration syndrome	4	-
	Newborn omphalitis with or without light hemorrhage	1	-
B3	Other electrolyte and metabolic disturbances in the neonatal period	1	-
	Congenital pneumonia	1	-
	Acute bronchiolitis	5	-
	Acute bronchitis	1	-
C	Non-specified acute myocarditis	-	1
	Other septicemias	-	1
	Bacterial pneumonia not classified elsewhere	3	-
	Pneumonia from unspecified microorganism	1	-
	Diarrhea and gastroenteritis presumably from infectious origin	1	-
	Dog bite or strike	1	-
D	Other choking or accidental strangling	1	-
	Pedestrian injured in other or unspecified transportation accidents	-	2
	Sudden infant death syndrome	4	-
	Metabolic disturbances of sphingolipids and other disturbances of lipid deposits	1	-
	Encephalocele	2	-
	Hydrocephalus	-	1
	Congenital hydrocephalus	2	-
	Congenital malformations of the cardiac chambers and valves	1	-
	Congenital malformation of the esophagus	1	-
DC	Congenital malformation of the cardiac septum	1	-
	Myasthenia gravis and other neuromuscular problems	-	1
	Neoplasm of unknown cause or unknown primary location and from unspecified locations	-	1
	Malignant neoplasm of the suprarenal gland	-	1
	Other chromosomal anomalies, not classified elsewhere	2	-
	Other congenital heart malformations	2	1
	Edwards Syndrome and Pataul Syndrome	1	-
MD	Other undefined and unspecified causes or mortality	4	-
Total		82	10

B1: Reducible through adequate maternal care during pregnancy.
B2: Reducible through adequate maternal care during birth.
B3: Reducible through adequate newborn care.
C: Reducible through adequate diagnosis and treatment.
D: Reducible through adequate health promotion connected to adequate health care.
OC: Other causes.
UD: Undefined.

Studies of prenatal care in Pelotas have identified limitations in quality of care, especially in the public sector which serves the population most susceptible to avoidable causes of infant death,[4,10,23] findings that are supported by our study. More complex and expensive tests, such as obstetric ultrasounds, are performed at the expense of easier and cheaper tests proven to reduce pre-maturity, such as syphilis serology and searching for urinary infections.[1] In addition, the rate of women that smoke during pregnancy among children born in 2004 was 25.1%, but among the poorest women, the smoking rate was greater (33.6%).[21] This shows the

Table 3. Number of live births, deaths in under ones, avoidable deaths until 48 months and avoidable deaths by type of BHU. Pelotas, Southern Brazil, 2008. (n = 91)

Location	Live births	Deaths	Óbitos 0 a 48 meses (%)	Avoidable deaths				
				< 1 year	B2	B3	C	D
(%)	Deaths 0 to 48 months	45 (1.8)	51 (2.0)	23	1	2	8	4
(%)	1,200	28 (2.3)	30 (2.5)	15	3	1	2	3
				4	-	-	2	1
				-	-	-	-	1
Total	4,231	82	94	42	4	3	12	9

UBS: Unidade Básica de Saúde (Basic Health Unit).
ESF: Estratégia de Saúde da Família (Family Health Strategy).
B1: Reducible through adequate maternal care during pregnancy.
B2: Reducible through adequate maternal care during birth.
B3: Reducible through adequate newborn care.
C: Reducible through adequate diagnosis and treatment.
D: Reducible through adequate health promotion connected to adequate health care.

need to invest in quality improvements in prenatal care offered to the poorest women.

Two other studies investigated causes of avoidable death among children under one year in Brazil. Between 1990 and 1992, Gomes et al[9] studied 189 deaths in the city of Presidente Prudente, Southeastern Brazil. They analyzed copies of death certificates; live birth certificates; questionnaire data from interviews of mothers, health professionals and medical reports; in addition to registration books from the hospital nurseries. Primary causes of death were reclassified according to criteria used by Taucher.[f] In the neonatal period, 22.2% of deaths could have been avoided with adequate birth care, 20.6% through timely diagnosis and treatment and 13.7% through good management of pregnancy. At least 7.9% of neonatal deaths were unavoidable, and over the remainder of the period, 4.2% were unavoidable, with infant mortality reducible by 12.2%.

Caldeira et al[5] studied a historical series of mortality in the first year of life in the metropolitan region of Belo Horizonte, Southeastern, between 1984 and 1998, using data from SIM and the Instituto Brasileiro de Geografia e Estatística. During the study period, infant mortality decreased from 48.5 to 22.1 deaths per 1,000 LB. Among neonatal deaths, perinatal conditions were the main group of avoidable causes (mostly, perinatal malnutrition, prematurity, hypoxia and asphyxia), followed by cardiovascular and respiratory problems. The triad of diarrhea, pneumonia and malnutrition were the main avoidable causes of death during the postneonatal period.

Comparison of the results from these studies to our study is limited by time (one decade or longer) and by geographical distance, as well as by the distinct methodology used to identify cause and classification of avoidable death. Nonetheless, the three studies indicate that avoidable infant deaths have been an important public health problem in Brazil over the

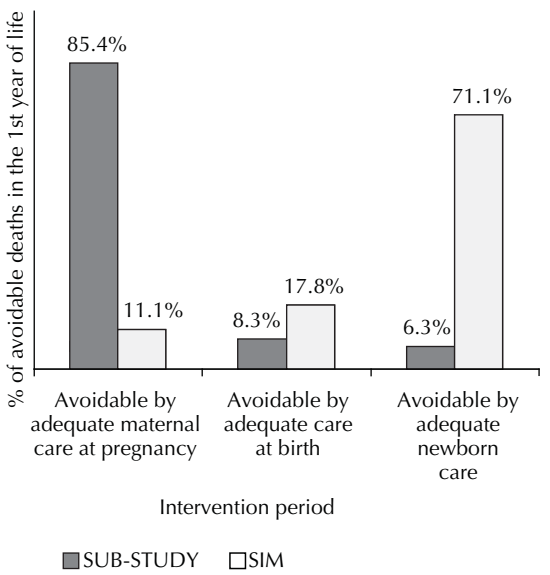

Figure. Comparison of the proportion of avoidable deaths, by adequate care during pregnancy, birth or to the newborn during the first year of life (n = 48) based on the state Mortality Information System (SIM). Pelotas, Southern Brazil, 2008. (n = 45)

past several decades. Attribution of avoidable causes of death was inconsistent when obtained by a direct method (our study) compared through the SIM, even though the proportion of avoidable deaths does not change substantially between the two sources. We identified the prenatal period as the time when more interventions to reduce avoidable deaths could occur. On the other hand, according to SIM data, interventions should focus on newborn care. For a city the size of Pelotas, this divergence has a large impact on the measures managers should adopt in order to reduce infant mortality. According to the results from SIM, manager should better equip neonatal intensive care

units and train and hire professionals for intensive neonatal care. According to our results, the manager should improve quality of prenatal care, irrespective of primary care facility. Therefore, our results demonstrate the need for primary prevention of prematurity, while the results from SIM indicate secondary or even tertiary prevention measures.

There are few available interventions to prevent prematurity, including prevention of maternal tobacco use during pregnancy,[13] identification of urinary tract infections during prenatal care[19] and use of progesterone among pregnant women with a history of previous pre-term birth.[12] These can all be performed during primary care.

The findings from the 2004 Cohort probably reflect the current situation in other medium-sized Brazilian cities with similar health service characteristics as Pelotas. Monitoring of deaths from avoidable causes would be an appropriate tool to evaluate the quality of maternal and child health care in Brazil. It is necessary, though, that the data source is reliable. Although the objective of the current study was not to measure the validity of information in SIM, the data allow us to anticipate that use of SIM could lead to inaccurate recommendations to managers. SIM is subject to the quality of death certificates and the competence of the doctor that attended to the death. Therefore, adequate training of doctors to perform death certificates is a necessary condition for use of SIM to monitor avoidable deaths.

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