ORIGINAL RESEARCH ARTICLE

OPEN ACCESS

AVOIDABLE CONDITIONS OF INFANT DEATHS AND ASSOCIATED FACTORS

*1Jessica Neves Pereira Zielinski, 2Pollyanna Kássia de Oliveira Borges, 3Clóris Regina Blanski Grden, 4Caroliny Stocco, 5Wesley Sousa Borges and 6Suely Godoy Agostinho Gimeno

1Nurse. Resident. Multidisciplinary Residency Program in Intensive care. Regional University Hospital of Campos Gerais. Ponta Grossa-PR

2Dentist surgeon. PhD. Department of Nursing and Public Health. State University of Ponta Grossa - PR. Graduate Program in Health Sciences. Address: Rua Fagundes Varela, 2600, Giana I, Ponta Grossa-PR

3Nurse. PhD. Department of Nursing and Public Health. State University of Ponta Grossa-PR

4Coordinator of the Epidemiological Surveillance of the Municipal Health Department of Ponta Grossa-PR

5Biomedical physician. Master. Health Sciences Sector. University Centre of Maringá Maringá. Curitiba-PR

6Nutritionist. Professor. Department of Preventive Medicine, Federal University of São Paulo. Sao Paulo-SP

ARTICLE INFO

ABSTRACT

Objective: to describe the avoidability of infant deaths and verify the associated factors. **Methods:** Time-series epidemiological study on infant deaths of the live births, from 2006 to 2014, in the city of Ponta Grossa - PR. **Results:** In the historical series studied, there were 609 deaths, of which 61.91% were considered avoidable. Deaths that could be prevented by adequate care for women during gestation and delivery and for newborns were responsible for 51.40% of all deaths. Regardless of other causes, avoidability was associated with birth weight and death in the neonatal period. **Conclusion:** The results of the study indicate the need for qualitative investment in maternal and child care and in interdisciplinary actions. Continuing education of workers, intersectoriality of proposals, promotion of autonomy, and empowerment of women and families in the care of the children are factors that can contribute to minimize avoidable deaths.

INTRODUCTION

Reducing infant mortality is a persistent challenge for developing countries. Much progress has been made in infant health care and between 1990 and 2012 in Latin America, the infant mortality rate dropped from 54 to 19 deaths per 1000 live births (United Nations, 2014). However, despite the decline (Brasil, 2015), preventable conditions are the leading causes of death in children under 5 years of age, and almost half of deaths in this population occur in the neonatal period (United Nations, 2017 and Santos, 2019). As the United Nations member countries proposed in the Sustainable Development Goals (SDG) (United Nations, 2017) to eradicate preventable deaths of newborns by 2030, efforts are being

intensified, including those of Brazil, to reduce inequities and ensure health and well-being for newborns. Thus, information on the development of newborns, assistance received by mothers during prenatal care and delivery, causes of death, and avoidability continue to be fundamental for the planning of strategies to prevent and reduce infant mortality (Rocha, 2011). Given the international and national movements to reduce preventable deaths in children, the social and emotional burden that these deaths generate and the possibility of intervening in the preventable factors of children deaths, this research was designed to diagnose the avoidability of infant deaths (Malta, 2007 and Malta, 2010) and to investigate the associated factors.

METHODS

This is a time-series epidemiological study on deaths of children under one year of age occurred among live births,

---

*Corresponding author: **Jessica Neves Pereira Zielinski**
Nurse. Resident. Multidisciplinary Residency Program in Intensive care. Regional University Hospital of Campos Gerais. Ponta Grossa-PR

from 2006 to 2014, in the city of Ponta Grossa - PR- Brazil. Ponta Grossa is a municipality located in the state of Paraná, Brazil, 102 km far from the capital city, with 341,130 inhabitants in 2016 (Instituto Brasileiro de Geografia e Estatística, 2016), and headquarters of the 3rd health region of the state of Paraná. The information for this study was collected from the Mortality (MIS) and Live Births (SINASC) Information System of the Municipal Health Department of Ponta Grossa-PR. Data came from Death Certificates (DC), Live Birth Certificates (LBC), and investigation files of infant mortality. The deaths that were investigated and those not investigated by the Municipal Committee for the Prevention of Fetal and Infant Mortality were included in this study. It is noteworthy that, from 2012 onwards, most of the deaths had their basic cause investigated by the committee ($\geq$ 75% of investigation). Infant deaths were categorized according to the basic cause declared in the DC. Among the deaths investigated by the Committee for Prevention of Fetal and Infant Mortality, the basic cause was used after the investigation.

The classification of avoidable or non-avoidable deaths was used (Malta, 2007 and Malta, 2015); according to the chapters of the International Classification of Diseases (ICD-10) (Organização, 2007), deaths could be avoided by: 1) Immunoprevention actions; 2) Adequate care for women during gestation and delivery and for newborns; 3) Appropriate diagnostic and treatment actions; 4) Adequate health promotion actions, linked to adequate health care actions; 5) Poorly defined causes and other causes (not clearly avoidable). The description of the outcomes also considered the subclassification of avoidable causes by adequate care for women during gestation and delivery and for newborns in avoidable by: 2.1) Adequate care for women during gestation; 2.2) Adequate care for women during delivery; 2.3) Adequate care for newborns (Malta, 2007 and Malta, 2010). Data were described in numbers and percentage according to the avoidability or non- avoidability of death, and according to demographic and mother-related variables. Data on gestational weeks were only considered in the deaths that occurred since 2012 onwards because this information was available in the most recent DC model implemented in 2011.

In the analysis of association, poorly defined conditions were excluded and avoidable deaths were compared with those that were not avoidable, according to the possible variables of exposure to avoidability (gender, birth weight, mother's education, etc.). The criteria for classification of birth weight, recommended by WHO (WHO, 1995) employed were: 2500g or more, normal birth weight; 2499-1500g, low birth weight; 1499 to 1000g, very low birth weight; and < 1000g, extremely low birth weight. The schooling of the mother was qualified according to the categories: no schooling or elementary school I (1-4 years of schooling); elementary school II (5-8 years of study); high school (9-11 years of study); higher education (12 or + years of study). The type of gestation was classified into the categories: single, double, and triple or more. Births were analyzed as vaginal or surgical and maternal age was subdivided into: < 20 years, 20-33 years, 34 years or more. Finally, according to the survival days of the children, the deaths were categorized into: early neonatal mortality (0 - 6 days of life); late neonatal mortality (7 - 27); and post-neonatal mortality (28 - 364 days). In a bivariate analysis, the chi-square test and the *p*-values were used; *p* values of < 0.05 were considered statistically significant. Variables that presented statistically significant association, in the chi-square test had

the ratios and differences of risks avoidable and non-avoidable death and their confidence intervals [95% CI] also calculated, according to the categories of exposure variables. The relative risks of death between avoidable and non-avoidable causes according to the exposure variables were adjusted for birth weight according to the recommendation of the classification of avoidability used in this study (Malta, 2007). Finally, avoidability was analyzed in a multiple Poisson regression model. The variable "avoidability of death" was considered as an outcome. All variables that presented crude *p*-values < 0.20 were included in the initial model as exposure to avoidable death. One by one the variables were removed from the model when the *p*-values modified the initial model and presented values of p > 0.20, except for birth weight which is considered by the literature as an independent factor for death within < 1 year. The research was carried out in accordance with Resolution 466/12 of the National Health Council, and approved by the Ethics Committee of Research with Humans of the State University of Ponta Grossa (UEPG), under protocol nº 1,055,806/2015.

RESULTS

The main findings of this study were the high frequency of infant deaths classified as avoidable and the prominent association of avoidability with birth weight and neonatal period. Between 2006 and 2014, there were 609 deaths of children under one year of age in the city of Ponta Grossa - PR. Despite oscillations, a decline in the historical series studied was observed. Of the 609 deaths, 56.32% (n = 343) were males and 98.47% (n = 578) of the white race/color. Deaths occurred most often in the hospital (89.82%, n = 547), followed by deaths at home (8.21%, n = 50). Between 2006 and 2011, most of the deaths occurred in children whose mothers had 9-11 years of schooling (40.68%; n = 177), followed by 4-7 years (36.41%; n = 158), while in the period from 2012 to 2014, the highest number of deaths occurred in children born to mothers with 5-8 years of schooling (32.57%; n = 57). In 85.06% of the deaths (n = 518) the type of gestation was single, 40.87% of the children (n = 235) were born at term, and 20.70% (n = 119) were extremely premature. There was a predominance of vaginal delivery (n = 295; 51.57%). When analyzing the average life expectancy of the deceased children, the lowest average (33.57 days of life) was observed in 2012, and the highest average (69.37 days of life) in 2014. The mean weight of the children at birth did not show great variation in the years studied, with a lower average in 2010 (1819.48g) and higher in 2009 (2228.50 g).

Normal birth weight ($\geq$ 2500g) was found only in 37.26% of the subjects surveyed. Otherwise, the median number of days lived and birth weight throughout the historical series were, respectively, 5 days and 1975g. Regarding the mother's age, the mean age was highest in 2011 (27.86 years) and lowest in 2006 (24.36 years). The mean duration of gestation was 32.52; 30.82 and 33.34 weeks in 2012, 2013 and 2014, respectively. According to the classification of avoidable or non-avoidable children deaths in the period 2006-2014, 28.90% (n = 176) of the deaths were non-avoidable, 9.20% (n = 56) were poorly defined, and 61.90% (n = 377) were avoidable. Among the avoidable causes, those avoidable due to adequate care for women during gestation and delivery and for newborns stood out, accounting for 51.40% of avoidable deaths (n = 313). Of these 313 deaths, when subclassified, 51.44% (n = 161) were avoidable due to adequate care for women during pregnancy,

Table 1. Avoidable and non-avoidable deaths according to health and social conditions of the mother-child binomial - Ponta Grossa, Paraná, 2006-2014

Condition		Non-avoidable	Avoidable	Total	χ^2 (p)
Sex of the child	Female	76(31.67)	164(68.33)	240(100.00)	0.005 (0.944)
	Male	100 (31.95)	213(68.05)	313(100.00)	
Birth weight	>=2500g	79 (44.89)	97(55.11)	176(100.00)	48.04 (0.000)
	2499-1500g	53 (44.17)	67 (55.83)	120(100.00)	
	1499-1000g	19 (23.46)	62 (72.54)	81 (100.00)	
	<1000g	19 (13.01)	127 (86.99)	146(100.00)	
Mother's schooling	Illiterate	-	6 (100.00)	6 (100.00)	12.55 (0.014)
	Elementary I	6 (28.57)	15 (71.43)	21 (100.00)	
	Elementary II	48 (27.12)	129 (72.88)	177(100.00)	
	High school	74 (32.60)	153 (67.40)	227(100.00)	
	Higher education	38 (46.34)	44 (53.66)	82 (100.00)	
Type of gestation	Single	161 (34.33)	308 (65.67)	469(100.00)	7.01 (0.030)
	Double	10 (17.54)	47 (82.46)	57 (100.00)	
	Triple or +	-	1 (100.00)	1 (100.00)	
Type of delivery	Vaginal	65(25.39)	191(74.61)	256(100.00)	11.40 (0.001)
	Surgical	104(39.25)	161(60.75)	265(100.00)	
Mother's age	<20 years	27 (23.68)	87 (76.32)	114(100.00)	9.54 (0.008)
	20-33 years	101(32.58)	209(67.42)	310(100.00)	
	>=34 years	42(43.75)	54 (56.25)	96 (100.00)	
Gestational week*	<22 weeks	1 (25.00)	3 (75.00)	4(100.00)	24.75 (0.000)
	22-27	5(11.36)	39(88.64)	44 (100.00)	
	28-31	5(29.41)	12(70.59)	17 (100.00)	
	32-36	15(53.57)	13(46.43)	28(100.00)	
	37-41	23(58.97)	16(41.03)	39(100.00)	
	42 e +	1 (25.00)	3 (75.00)	4 (100.00)	
Number of live children prior to the deceased child	None	14(25.45)	41(74.55)	55 (100.00)	1.75 (0.625)
	1	57 (30.65)	129 (69.35)	191(100.00)	
	2	53 (34.42)	101 (65.58)	154(100.00)	
	3 or +	41 (33.33)	82 (66.67)	123(100.00)	
Number of deceased children prior the deceased child	None	50 (36.76)	86 (63.24)	136(100.00)	3.014 (0.389)
	1	93 (30.90)	208 (69.10)	301(100.00)	
	2	11 (23.91)	35 (76.09)	46(100.00)	
	3 or +	4 (20.00)	16 (80.00)	20(100.00)	
Survival days of the child	0-6 days	82 (25.71)	237 (74.29)	319(100.00)	26.08 (0.000)
	7-27 days	24 (26.37)	67 (73.63)	91(100.00)	
	>=28 days	70 (48.95)	73 (51.05)	143(100.00)	

Data available only for the years 2012-2014 (n=148).

Table 2. Crude risk ratio of avoidable deaths in <1 year, risk difference, confidence intervals, and adjusted risk ratio for birth weight condition, according to health and social conditions of the mother-child binomial - Ponta Grossa, Paraná, 2006-2014

Condition	Compared groups	RR [CI 95%]*	Risk difference (RD) [CI95%]**	χ^2 (p)	RR adjusted for birth weight condition [95% CI]*				(p)
					Extreme low weight	Very low weight	Low weight	Normal weight	
Weight	Low weight[+] vs normal weight	1.34 [1.15-1.55]	0.18 [0.01; 0.27]	18.54 (0.000)	-	-	-	-	
Mother's schooling	No schooling or basic vs. high or higher school	1.13 [1.01-1.27]	0.08 [0.006;0.16]	4.27 (0.008)	1.01 [0.89-1.14]	1.03 [0.80-1.34]	1.10 [0.80-1.51]	1.45 [1.12-1.87]	0.055
Type of birth	Vaginal vs surgical	0.81 [0.72-0.92]	-0.13 [-0.21;-0.06]	11.40 (0.0007)	0.96 [0.84-1.09]	0.81 [0.63-1.02]	0.77 [0.57-1.04]	0.82 [0.62-1.08]	0.3073
Gestational week	≤36 weeks vs >37 weeks	1.63 [1.14- 2.33]	0.28 [0.10;0.45]	9.81 (0.0017)	0.93 [0.87-1.00]	-	-	0.88 [0.35-2.21]	0.0000
Mother's age	Teenagers vs adults	1.18 [1.04-1.33]	0.11 [0.02;0.21]	5.38 (0.0203)	1.00 [0.87-1.16]	1.15 [0.87-1.50]	1.28 [0.92-1.78]	1.31 [0.98-1.73]	0.2059
Survival days of the child	0-27 vs ≥ 28 days	1.45 [1.22-1.72]	0.23 [0.14;0.32]	26.07 (0.0000)	1.23 [0.92-1.65]	1.03 [0.75-1.40]	1.16 [0.79-1.70]	1.69 [1.20-2.36]	0.1591

*Death risk ratio from avoidable and non-avoidable causes. **Difference in risk of death between avoidable and non-avoidable causes. [+]Children of the categories extreme low weight, very low weight and low weight were grouped.

Table 3. Explanatory initial and final models of avoidable deaths in multivariate of Poisson regression analysis – Ponta Grossa-Paraná, 2006-2014

		Initial Model		Final Model	
Variables	Compared groups	RR(p)	95%CI	RR (p)	95%CI
Birth weight	Low weight* vs normal weight	1.23 (0.101)	[0.96;1.59]	1.30 (0.033)	[1.02;1.65]
Days of life	0-27 vs 28-364 days	1.33 (0.045)	[1.01;1.74]	1.34 (0.033)	[1.02;1.77]
Mother's age	teenagers vs adults	1.07 (0.589)	[0.83-1.38]	-	-
Schooling	Elementary school vs high school or higher education	1.14 (0.123)	[0.67;1.04]	-	-
Type of delivery	Vaginal vs surgical	0.84 (0.794)	[0.32;4.36]	0.83 (0.087)	[0.67-1.02]
Type of gestation	Single vs double or more	1.20 (0.273)	[0.86;1.65]	-	-

*Children of the categories extreme low weight, very low weight and low weight were grouped.

14.70% (n = 46) avoidable due to adequate care for women during delivery, 33.87% (n = 106) avoidable due to adequate care for newborns. In the analysis of association, the poorly defined deaths (n = 56) were excluded from the total of 609 deaths, and 553 deaths were analyzed. Of these, 68.17% (n = 377) were avoidable and 32.83% (n = 176) non-avoidable. Considering the relationship between the health and social conditions of the 553 deceased children with the avoidability of the death (Table 1), it was found that both normal weight and low weight children had a higher percentage of avoidable deaths. However, in children with very low birth weight and extreme low birth weight, avoidable deaths exceeded 70% (p = 0.000). It is noticeable in Table 1 that among mothers without schooling, with elementary school I or II, the percentage of avoidable deaths was equal to or close to the total number of deaths in the corresponding category (p = 0.014). Among vaginal deliveries, 74.61% of the deaths were avoidable, and among surgical deliveries, 39.25% were considered non-avoidable (p = 0.001). Regarding maternal age, a higher percentage of avoidable deaths was found among younger women (p = 0.008). Children who were born prematurely until the 31st week of gestation, as well as after the 42nd gestational week, had a higher percentage of avoidable deaths (p=0.000). It was also observed that, in both early and late neonatal period, the percentage of avoidable deaths was higher than that of non-avoidable deaths (p = 0.000).

Table 2 shows that the risk of death from avoidable causes among children born with low birth weight was 1.34-fold higher than the risk of children weighing more than 2500g (p = 0.000). In the crude analysis, schooling (p = 0.008), births before 37 gestational weeks and teenage pregnancy were considered explanatory for avoidable deaths. Vaginal birth (p = 0.0007) and maternal age above 34 years were protective factors against avoidable deaths (p = 0.0203). When avoidable deaths that occurred between 22nd-36th and 37th or more gestational weeks were compared, it was found that the risk of avoidable deaths was 1.63-fold higher than the risk of non-avoidable deaths (Table 2). In addition, more than a quarter of avoidable deaths could have been avoided if there was prevention of expulsion of the newborn before the 37th gestational week (RD = 0.28, p = 0.0017). Regarding the survival days of the child at death, it was observed that if it were possible to avoid deaths in the neonatal period, 23% (p = 0.000) of the avoidable deaths could have been avoided. However, when the risks were adjusted for the condition of birth weight (extreme low weight, very low weight, low weight, or normal weight)[8], the associations found in the crude analysis lost statistical significance (Table 2). In the multivariate analysis (Table 3), children who were born weighing < 2500g had a 30% greater risk of having death explained by avoidable causes when compared to children who were born with normal weight (p = 0.033). Similarly, children who died in the neonatal period had 1.34-fold higher risk of

avoidable death than children who died in the post-neonatal period (p = 0.033).

DISCUSSION

In this study, it was verified that the municipality studied has accompanied the decrease in infant mortality observed in Brazil (Malta, 2006) and reached the national and international targets for the considered period (United Nations, 2015). Other studies conducted in the state of Paraná and in the country have found similar findings of temporal reduction in infant death rates (Rocha, 2017; Malta, 1997; United Nations, 2015; Maia, 2018; Ferrari, 2013) and it is assumed that maternal and child health policies have been quantitatively effective in combating children deaths. Similarly to other national studies (Maia, 2018 and Mombelli, 2012), it was found that deaths were more frequent among children of mothers with low schooling. Likewise, when infant deaths were analyzed according to avoidability, the risk of death from avoidable causes was higher among mothers with low schooling, as pointed out by other authors (Santos, 2004). The literature indicates that the lack of access to information and (financial, human and technological) resources increases the risk of complications or deaths for mother and child (Mombelli, 2012). Knowledge of the role of schooling in determining infant deaths is not recent, but has been ratified by the Development Program of the United Nations as an important determinant to be faced in the coming years (United Nations, 2016). Avoidable deaths were less frequent among mothers who underwent vaginal delivery. The literature reports that vaginal delivery reduces complications related to hospital infections, both for the mother and the child (Noronha, 2017). However, due to inadequate indication or care, greater morbidity can also be found among babies born through vaginal delivery (Cardoso, 2010).

In this investigation, a high number of full term children (37th to 41th weeks of gestation) and children with low average birth weight died. The longer the gestation time, the greater the child's weight at birth (Carniel, 2008), however, in the present study, 66% of the deceased children had some inadequate weight condition at birth. Deaths of low birth weight children are associated with maternal life conditions, insufficient prenatal consultations, low gestational age at birth, low Apgar in the first and fifth minutes of life and presence of congenital anomalies (Gaiva, 2014). Thus, the epidemiological picture of the high frequency of low birth weight found in this study could suggest failures in the care provided during pregnancy and delivery. Urinary tract infections (UTIs) are frequent, affecting between 17 and 20% of pregnant women, and a recognized cause of low birth weight, restricted uterine growth and prematurity (Brasil., 2010). Extending the quality of prenatal care can impact the reduction of UTIs and their consequences. UTIs could be associated with the findings of

this study on low birth weight and higher number of deaths in the perinatal period. But other studies must be carried out to prove or rule out such a hypothesis. In the present study, we found 9.19% of deaths were due to poorly defined causes. This value is higher when compared to other national surveys (Jobim, 2017). This percentage was 4.35% in Brazil (2006-2013) and the coefficient of infant mortality from poorly defined causes was 0.63 in the same period (Brasil, 2005). However, there is a national effort to ensure that Epidemiological Surveillance, supported by Committees for the Prevention of Fetal and Children Mortality can clarify the causes of all infant deaths in municipal territories. However, as the data analysis period of this research involved years prior to the implementation of this strategy, the high percentage of deaths due to poorly defined causes could have been due to insufficient coverage of the research.

The percentage of avoidable causes in the period 2006-2014 was lower when compared to surveys in Porto Alegre and Pelotas, Rio Grande do Sul (RS) (Jobim, 2008 and Silva, 2012), which reported a percentage frequency of 76.6% in the period between 2000-2003, and 72.9% in the period between 2005-2008. In these investigations carried out in Rio Grande do Sul, avoidable cause due to adequate care for the woman during gestation and delivery and for newborns presented more deaths. Likewise, the frequency of avoidability was lower than that found in the investigation that evaluated avoidability in Brazil (Malta, 2010), in which, 69.41% of the deaths in 2006 were considered avoidable. A higher percentage of avoidable deaths due to adequate care for women during pregnancy and delivery for newborns suggest that services are fragile in carrying out the actions recommended by the policy on maternal and child health in the state of Paraná (Paraná, 2015). In this policy, it is recommended the classification of gestational risk, 6 prenatal and 1 postnatal consultations, and diagnostic tests to screen for diseases. Like most Brazilian territories, the place where the present research was carried out has had Family Health Strategy teams for more than a decade, and it is up to these teams, with the support of Community Health Agents, to actively search for pregnant women and children who do not attend the health care posts, classify their risk, follow them longitudinally, and provide treatment when any morbidity is detected.

In the analysis of the underlying causes of avoidable deaths, the one that most appeared was the P22.0 cause of ICD-10 (respiratory distress syndrome of newborn), which is classified as "avoidable due to adequate care for women during gestation" because it is characteristic of prematurity (Malta, 2010). The second most common cause of avoidable deaths was the P36.9 cause of ICD-10 (unspecified bacterial sepsis of newborn). This cause can be prevented with adequate care for the newborn. Unspecified bacterial sepsis is among the worldwide causes of children morbidity and mortality; this fact emphasizes the need for measures of adequate care and preventive infection control (Bentlin, 2015). The results of the multiple model in the analysis of association in the present study showed low birth weight and neonatal deaths as independent factors the avoidability of infant death. In addition to prevention of low birth weight, if the child is born with inadequate weight, surveillance should include monitoring of oxygenation and breathing status, indications of neonatal sepsis and neonatal complications. In cases of unavailable treatment or unsatisfactory responses to treatment, children should be forwarded (WHO, 1995).

However, many Brazilian municipalities do not have beds in neonatal or pediatric intensive care units (NPICUs) available for the monitoring of the situation. Regulatory centers should consider whether or not the case is urgent to ensure timely care. A recently published study on neonatal mortality in a municipality in the south of the country (Santos, 2016) found that almost all mothers who lost babies had given birth in maternity hospitals prepared to assist low- and medium-risk pregnancies without NPICUs. It is, therefore, appropriate to reinforce, in the care services for low- and medium-risk pregnancies, the programmed schedules of professional training, the agreements between municipalities of reference and counter reference, and the creation or revision of protocols with flowcharts that direct the complicated cases to beds of NPICUs. For developing countries, WHO advises that when the incidence of low birth weight is > 15%, populations should be considered at high risk for infant morbidity and mortality. In these cases, there should be maternal health surveillance and interventions, such as nutritional supplementation and incentives to stop smoking among pregnant women (WHO, 1995). Among all the children who were born alive in the studied territory, during the same period (2006-2014), the incidence of low weight was 9.2% (Paraná, 2016). However, all the subjects evaluated in this study were cases of death and, as more than half of these children who died had low weight, they were assumed to be subjects with the worst survival conditions. This further stresses the importance of low weight prevention for the various measures already mentioned.

Since most of the deaths in this population were classified as avoidable by SUS, it is suggested that the reduction of infant mortality may be directly linked to strategies that increase fetal growth and improve birth weight. Given the large reduction in post-neonatal deaths worldwide, the highest incidence of infant deaths occurs in the neonatal period (United Nations, 2017). This epidemiological panorama is repeated in the state of Paraná (Ferrari, 2017). If this period is an independent predictor of avoidable infant deaths, as presented in this research, reflections and interventions on the quality of care provided to mothers, fetuses, and neonates are necessary. The unavailability of beds in neonatal intensive care units, monitoring of low birth weight, prematurity and the lack of mechanisms for intervention, complications during pregnancy and delivery, maternal socioeconomic factors, and access to health services are some of the possible explanations for neonatal deaths. These causal factors require intervention projects in the territory studied, and in all Brazilian states with a similar reality, in order for Brazil to achieve one of the SDG of eradicating avoidable deaths by the year 2030 (De Jongh, 2018 and Gülmezoglu, 2016).

Mortality in the neonatal period, just like birth weight, are objects of complex determination (Gülmezoglu, 2016), which escape from the explanation of a single area of knowledge. Difficult problems to solve require complex interdisciplinary interventions, which will not belong to any of the health knowledge areas exclusively, but rather fit into the new reality that is the demand for reduction of infant deaths to levels that can be explained only by unavoidable issues. Thus, the avoidability of infant deaths involves rethinking, in an interdisciplinary way, the health production in Brazil, the work process and team governance, the use of clinical management tools extended to the mother-child binomial, the creation of sustainable networks for maternal and child health care, as well as their interconnection with other networks. The

limitations of this research involve the analysis of secondary data on infant deaths, some of them not investigated. Also, the results refer to a particular site in the South of Brazil. Therefore, it is suggested that other researches be carried out with other study designs to clarify the magnitude of the problem in the state and in the national territory. However, the results of the present research may represent a contribution for managers and health teams to know the circumstances that increase the risk for avoidable deaths and to reflect on what actions, and how, can be put into practice to minimize the findings.

Conclusion

Despite the investments made, the public policies for maternal and child health implemented to reduce children mortality in the territory studied, and the great decline of these deaths in recent years, this research left clear that a large part of infant deaths could be prevented with the improvement of care for the mothers during pregnancy and delivery and for newborns. The results found in this study indicate that investments in quality of care for the mother-child binomial should be increased with a focus on the surveillance actions of intrauterine development and growth monitoring, fetal weight gain, and also surveillance of morbidities associated with such conditions that increase infant deaths.

REFERENCES

Bentlin MR, Rugolo LMSS, Ferrari LSL. Practices related to late-onset sepsis in very low-birth weight preterm infants. J Pediatr [Internet]. 2015 [cited 2017 Jul 09]; 91:168-74. Available from: http://www.scielo.br/pdf/jped/v91n2/0021-7557-jped-91-02-00168.pdf DOI: http://dx.doi.org/10.1016/j.jped.2014.07.004.

Brasil. Ministério da Saúde. Departamento de informática do SUS. Estatísticas Vitais. Nascidos Vivos [Internet]. Brasília; 2015 [citado 2015 out. 14]. Disponível em:http://www.datasus.gov.br

Brasil. Ministério da Saúde; Departamento de Informática do SUS. Informações em Saúde. Estatísticas Vitais [Internet]. Brasília; 2015 [citado 2015 set. 17]. Disponível em: http://www2.datasus.gov.br/Datasus/ index.php?area=0205

Brasil. Ministério da Saúde; Secretaria de Atenção à Saúde, Departamento de Ações Programáticas Estratégicas. Gestação de alto risco: manual técnico. 5ª ed. Brasília; 2010.

Cardoso PO, Alberti LR, Petroianu A. Morbidade neonatal e maternas relacionada ao tipo de parto. Ciênc. saúde coletiva [Internet]. 2010 [citado 2017 maio 21]; 15 (2): 427-435. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1413-81232010000200019 DOI: http://dx.doi.org/10.1590/S1413-81232010000200019.

Carniel EF, Zanolli ML, Monteiro MARG, Morcillo AAM. Determinantes do baixo peso ao nascer a partir das Declarações de Nascidos Vivos. Rev Bras Epidemiol [Internet]. 2008 [citado 2017 maio 21]; 11:169-79. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1415-790X2008000100016 DOI: http://dx.doi.org/10.1590/S1415-790X2008000100016.

De Jongh, TE, Gurol–Urganci I, Allen E, Zhu NJ, Atun R. Integration of antenatal care services with health programmes in low– and middle–income countries: systematic review. J Global Health [Internet] 2016 [cited 2018 May 03]; 6 (1), 010403. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4871065/pdf/jogh-06-010403.pdf DOI: http://doi.org/10.7189/jogh.06.010403

Ferrari RAP, Bertolozzi MR, Dalmas JC, Girotto E. Determining factors for neonatal mortality in a city in the Southern Region of Brazil. Rev esc enferm USP [Internet]. 2013 [cited 2017 Jan 17]; 47(3): 531-538. Avaliable from:http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0080-62342013000300531 DOI: http://dx.doi.org/10.1590/S0080-623420130000300002.

Gaiva MAM, Fujimori E, Sato APS. Neonatal mortality in infants with low birth weight. Rev esc enferm USP [Internet]. 2014 [cited 2017 May 21]; 48 (5): 778-786. Available from: http://www.scielo.br/readcube/ epdf.php?doi=10.1590/S0080-6234201400005000002&pid=S0080-62342014000500778&pdf_path=reeusp/v48n5/0080-6234-reeusp-48-05-778.pdf&lang=en DOI: http://dx.doi.org/10.1590/S0080-6234201400005000002.

Gülmezoglu AM, Lawrie TA, Hezelgrave N, Oladapo OT, Souza JP, Gielen M, et al. Interventions to Reduce Maternal and Newborn Morbidity and Mortality. In: Black RE, Laxminarayan R, Temmerman M, Walker N, editors. Reproductive, Maternal, Newborn, and Child Health: Disease Control Priorities, Third Edition (Volume 2). Washington (DC): The International Bank for Reconstruction and Development / The World Bank. Chapter 7. [Internet] 2016 [cited 2018 May 03]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK361904/ DOI: 10.1596/978-1-4648-0348-2_ch7

Instituto Brasileiro de Geografia e Estatística (IBGE). Infográficos: dados gerais do município [Internet]. Rio de Janeiro: IBGE; 2016 [citado 2017 fev. 15]. Disponível em: http://cidades.ibge.gov.br/painel/painel.php?codmun = 411990

Jobim R, Aerts D. Mortalidade infantil evitável e fatores associados em Porto Alegre, Rio Grande do Sul, Brasil, 2000-2003. Cad Saúde Pública [Internet]. 2008 [citado 2017 maio 2107]; 24: 179-87. Disponível em: http://www.scielo.br/scielo.php?pid=S0102-311X2008000100018&script=sci_abstract&tlng=pt DOI: http://dx.doi.org/10.1590/S0102-311X2008000100018.

Maia LTS, Souza WV, Mendes ACG. Diferenciais nos fatores de risco para a mortalidade infantil em cinco cidades brasileiras: um estudo de caso-controle com base no SIM e no SINASC. Cad Saúde Pública [Internet]. 2012 [cited 2018 May 03]; 28(11): 2163-2176. Available from: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0102-311X2012001100016&lng=en. DOI: http://dx.doi.org/10.1590/S0102-311X2012001100016.

Malta DC, Duarte EC, Almeida MF, Dias MAS, Morais Neto OL, Moura L, et al. Lista de causas de mortes evitáveis por intervenções do Sistema Único de Saúde do Brasil. Epidemiol Serv Saude [Internet]. 2007 [citado 2015 out. 16]; 16:233-44. Disponível em: http://scielo.iec.gov.br/pdf/ess/v16n4/v16n4a02.pdf DOI: http://dx.doi.org/10.5123/S1679-49742007000400002.

Malta DC, Duarte EC, Escalante JJC, Almeida MF, Sardinha LMV, Macário EM, et al. Mortes evitáveis em menores de um ano, Brasil, 1997 a 2006: contribuições para a avaliação de desempenho do Sistema Único de Saúde. Cad Saúde Pública [Internet]. 2010 [citado 2016 nov. 22]; 26: 481-91. Disponível em: http://www.scielo.br/scielo.php?pid=S0102-311X 2010000300006&script=sci_

abstract&tlng=pt   DOI: http://dx.doi.org/10.1590/S0102-311X2010000300006.

Malta DC, Sardinha LMV, Moura L, Lansky S, Leal MC, Szwarcwald CL, et al. Atualização da lista de causas de mortes evitáveis por intervenções do Sistema Único de Saúde do Brasil. Epidemiol Serv Saúde [Internet]. 2010 [citado out. 2015 20]; 19:173-176. Disponível em: http://scielo.iec.gov.br/pdf/ess/v20n3/v20n3a16.pdf   DOI: http://dx.doi.org/10.5123/S1679-49742011000300016

Mombelli MA, Sass A, Molena CAF, Téston EF, Marcon SS. Risk factors for child mortality in towns of Paraná State (South Brazil), from 1997 to 2008. Rev Paul Pediatr [Internet]. 2012 [cited 2017 May 21]; 30:187-94. Available from: http://www.scielo.br/readcube/epdf.php?doi=10.1590/S0103-05822012000200006&pid=S0103-05822012000200006&pdf_path=rpp/v30n2/en_06.pdf&lang=en   DOI: http://dx.doi.org/10.1590/S0103-05822012000200006.

Noronha GA, Torres TG, Kale PL. Análise da sobrevida infantil segundo características maternas, da gestação, do parto e do recém-nascido na coorte de nascimento de 2005 no Município do Rio de Janeiro-RJ, Brasil. Epidemiol Serv Saude [Internet]. 2012; [citado 2017 maio 21]; 21:419-30. Disponível em: http://scielo.iec.gov.br/scielo.php?script=sci_arttext&pid=S1679-49742012000300007   DOI: http://dx.doi.org/10.5123/S1679-49742012000300007.

Organização Mundial da Saúde. Classificação Estatística Internacional de Doenças e Problemas Relacionados à Saúde. 10ª ed. rev. São Paulo; 2007.

Paraná. Secretaria de Estado da Saúde do Paraná; Superintendência de Atenção à Saúde. Linha Guia da Rede Mãe Paranaense [Internet]. Paraná; 2013[citado 2015 set. 17]. Disponível em: http://www.saude.pr.gov.br/arquivos/File/ACS/linha_guia_versao_final.pdf

Paraná. Secretaria Estadual de Saúde; Sistema de informações sobre mortalidade (SIM) e nascidos vivos (SINASC). Nascidos vivos segundo local de residência e peso ao nascer. [Internet]. Paraná; 2016 [citado 2016 nov. 05]. Disponível em: http://www.tabnet.sesa.pr.gov.br/tabnetsesa/dh?sistema/sinasc99diante/nascido

Rocha R, Oliveira C, Silva DKFS, Bonfim C. Mortalidade Neonatal e evitabilidade: Uma análise do perfil epidemiológico. Rev Enferm UERJ [Internet]. 2011 [citado 2017 fev. 25]; 19: 114-20. Disponível em: http://www.facenf.uerj.br/v19n1/v19n1a19.pdf   DOI: http://dx.doi.org/10.5935/0034-7167.20140027.

Santos EP, Ferrari RAP, Bertolozzi MR, Cardelli AAM, Godoy CB, Genovesi FF. Mortalidade entre menores de um ano: análise dos casos após alta das maternidades. Rev esc enferm USP [Internet] 2016 [cited 2018 May 03]; 50 (3): 390-398. Available from: http://www.scielo.br/readcube/epdf.php?doi=10.1590/S0080-62342016000400003&pid=S0080-62342016000300390 &pdf_path=reeusp/v50n3/0080-6234-reeusp-50-03-0390.pdf&lang=en DOI: http://dx.doi.org/ 10.1590/S0080-623420160000400003

Santos IS, Matijasevich A, Gorgot LRMR, Valle NCJ, Menezes AM Óbitos infantis evitáveis nas coortes de nascimentos de Pelotas, Rio Grande do Sul, Brasil, de 1993 e 2004. Cad. Saúde Pública [Internet]. 2014 [citado 2018 maio 03]; 30(11): 2331-2343. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0102-311X2014001102331&lng=en. DOI: http://dx.doi.org/10.1590/0102-311X00129413.

Silva VLS, Santos IS, Medronha NS, Matijasevich A. Mortalidade infantil na cidade de Pelotas, estado do Rio Grande do Sul, Brasil, no período 2005-2008: uso da investigação de óbitos na análise das causas evitáveis. Epidemiol Serv Saúde [Internet]. 2012 [citado 2017 jun. 16]; 21: 265-74. Disponível em: http://scielo.iec.gov.br/pdf/ess/v21n2/v21n2a09.pdf   DOI: http://dx.doi.org/10.5123/S1679-49742012000200009.

United Nations. Sustainable Development Goals: 17 Goals to Transform our World. [Internet]. New York: UN; 2016 [cited 2017 Fev 13]. Available from: http://www.un.org/sustainabledevelopment/health/

United Nations. The Millenium Development Goals Report [Internet]. New York: UN; 2015 [cited 2016 May 23]. Available from: http://www.un.org/millenniumgoals/2015_MDG_Report/pdf/MDG%202015%20rev%20(July%201).pdf

United Nations. The Millennium Development Goals Report 2014 [Internet]. New York: UN; 2014 [cited 2017 Fev 16]. Available from: http://www.undp.org/content/undp/en/home/librarypage/mdg/the-millennium-development-goals-report-2014.html

United Nations. United Nations Development Program. Sustainable Development Goals. 3 Goal-Good Health and Well Being [Internet]. New York: UN; 2016 [cited 2017 Feb 16]. Available from:http://www.undp.org/content/undp/en/home/sustainable-development-goals/goal-3-good-health-and-well-being.html.

World Health Organization (WHO). WHO Expert Commitee on Physical Status. The use and interpetation of anthropometry: report of a WHO expert comittee. Geneva: WHO; 1995.

****