

Classification systems for avoidability of infant deaths: different methods, different repercussions?

Classificações de evitabilidade dos óbitos infantis: diferentes métodos, diferentes repercussões?

Clasificaciones de evitabilidad de los óbitos infantiles: ¿diferentes métodos, diferentes repercusiones?

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Abstract

The objective of this study was to compare the avoidability of infant deaths according to different classification methods. This was a descriptive comparative study from 2006 to 2013 in Espírito Santo State, Brazil, focusing on the classification of 5,316 infant deaths according to five different methods. The methods of the International Collaborative Effort on Infant Mortality (ICE) and the SEADE Foundation correctly classified the highest proportions of deaths as avoidable versus unavoidable (94.6% and 94.4% correct classification, respectively). Most deaths resulted from quality problems in prenatal, childbirth, and postpartum care, regardless of which classification method was used. There were also considerable numbers of deaths from "ill-defined" causes according to all the methods, suggesting difficulty in access or precious care in health services. Avoidability methods provide an important instrument for diagnosis of quality problems in health services performance and orientation of measures to reduce avoidable infant deaths. Thus, strengthening maternal and child care and investment in training and capacity-building for health professionals and services are priorities for public policies to reduce infant mortality.

Maternal and Child Health; Infant Mortality; Cause of Death

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Introduction

Avoidable deaths are considered “sentinel events” that include unnecessary incidents, preventable with the available medical technology or that would not occur if health services functioned properly¹. Such events suggest the health system’s inability to provide measures to reduce deaths from avoidable causes, especially infant deaths.

Infant mortality is defined as deaths that occur in the first year of life and serves as an indicator of a region’s socioeconomic development². Thus, investigating the causes of infant deaths is essential for orienting health measures to reduce mortality. For Brazil as a whole, from 2006 to 2012, the infant mortality rate from avoidable causes dropped from 11.6 to 9.3 per thousand live births (Brazilian Health Informatics Department. <http://tabnet.datasus.gov.br/cgi/deftohtm.exe?sim/cnv/evita10uf.def>, accessed on 03/Nov/2015).

The first step in analyzing infant mortality involves selecting a classification method for causes of death, since the advantages and disadvantages vary according to the objective³. In recent decades, several classification methods have been elaborated in different regions of the world to classify the causes of infant deaths as “avoidable”. These classifications include regional, social, economic, and health-systems characteristics. The oldest classification was elaborated in Chile in 1979 by surgeon Erica Taucher, due to the high infant mortality prevailing in that country⁴. To classify avoidability, Taucher⁴ considered the family’s socioeconomic status, including living conditions, mother’s schooling, child’s nutritional status, and access to health services. In 1980, the Wigglesworth⁵ classification was developed in Europe by a pediatric pathologist who proposed an alternative method for classifying the causes of infant mortality, using easily accessible clinical information and dispensing with autopsy data. This simplified classification included two stages: first the infant mortality rate is calculated, based on birth weight brackets; later, the deaths allocated in each weight group are classified in groups proposed by the Wigglesworth classification, modified by Keeling et al.⁶.

Some studies in Brazil have used this method for classification of avoidability^{7,8,9}, since it is simple, reliable, and effective, allowing comparison between locations. However, Lansky et al.³ suggested that the classification add the analysis of the moment at which the pregnant woman first receives care, since in Brazil early access to health services can still be difficult. Care during labor and childbirth also needed to be added to the equation, since many Brazilian women still experience difficulty in obtaining hospital admission when entering labor¹⁰.

Based on the Wigglesworth classification⁵, in 1989 the *International Collaborative Effort on Infant Mortality* (ICE)¹¹ proposed a similar methodology in the USA to facilitate comparison between countries. They added causes of sudden death, external causes, and infection to the classification¹¹. In Brazil, the first method for classification of infant deaths was developed by Luis Patrício Ortiz, better known as the *List of the São Paulo State Foundation System for Data Analysis* (SEADE)¹². The method was created to analyze the population’s health conditions in the State of São Paulo, in order to investigate avoidable deaths according to causes of diseases¹².

In 2007, Malta et al.¹³ elaborated the most recent Brazilian classification of infant deaths, called the *List of Causes of Avoidable Deaths through Interventions in the Brazilian Unified National Health System*. This method for classification of deaths proposed changes to the SEADE Foundation List¹², considering the causes of death in which avoidability depends on the available technology in Brazil, the technology provided by the Brazilian Unified National Health System (SUS), and the technology accessible to the majority of the Brazilian population. The method also allows investigation of deaths in the post-neonatal period as a function of the incorporation of intestinal diseases and pneumonias, prevalent at the time¹³.

This article discusses how initiatives for classification of deaths by causes have been a national and international effort in recent years. The process highlights the importance of Committees for the Prevention of Fetal and Infant Death in Brazil since 1999, implemented gradually in the states and municipalities to encourage and reinforce the investigation of deaths and analyze the avoidability of deaths, followed by analysis of the problems according to the classifications recommended by the Ministry of Health, such as SEADE Foundation, the *Brazilian List of Avoidable Causes of Death*, and the expanded Wigglesworth classification¹⁴.

The use of these classification methods thus allows identification of the leading causes of death. The diagnosis can help orient health measures for the pediatric population in order to reduce avoidable deaths and compare infant mortality patterns in different areas ⁷.

Various classification systems have thus been proposed, each with strengths and weaknesses, according to their objectives. However, comparisons between the methods have been a challenge for summarizing the research findings, due to differences in the classification systems, periods analyzed, and possibility of bias in the different distributions of birth weight in different locations ³.

Given the topic's relevance, the current study aimed to compare the avoidability of infant deaths and analyze reducibility groups according to the different classification methods applied to infant deaths in Espírito Santo State from 2006 to 2013.

Methodology

This was a descriptive comparative study of the 5,316 deaths in children under one year of age in Espírito Santo State, Brazil, from January 1, 2006, to December 31, 2013, based on five classification methods for the avoidability of infant death. The data source on deaths under one year of age was the Mortality Information System (SIM) of the Brazilian Ministry of Health.

Underlying causes of deaths and other necessary information for classification of avoidability were obtained from the digitized notification forms on infant and neonatal death, provided by the Espírito Santo State Health Secretariat (SESA-ES). Recording of cause of death was based on the International Classification of Diseases, 10th revision (ICD-10).

The notification forms yielded the variables to attribute avoidability to the infant death: year in which the death occurred; type of death; sex; race/color; region where the death occurred; place of death; healthcare establishment in which the death occurred; maternal age bracket; maternal schooling; maternal occupation; number of live children; number of deceased children; type of pregnancy; gestational age bracket in weeks; type of delivery; time of death in relation to birth; birth weight bracket; medical care; surgery; and confirmation of diagnosis by autopsy.

We began by selecting only the classification methods for causes of infant death that used the International Classification of Diseases (ICD), which included the following methods: Taucher ⁴, Wigglesworth ⁵, ICE ¹¹, SEADE Foundation ¹², and *Brazilian List of Avoidable Causes of Death* ¹³.

Next, we constructed algorithms for each classification by analyzing each infant death and its respective underlying cause of death recorded on the notification form. It was thus possible to classify all infant deaths according to the avoidability criteria from each proposed method.

The avoidability criteria proposed by Taucher ⁴ were based on the 9th revision ICD (ICD-9), divided into three sections: avoidable deaths, unavoidable deaths, and deaths from unknown causes. Avoidable deaths, in turn, include eight groups of causes, distinguishing between infants under 28 days and infants between 28 days and 11 months of age, namely: causes reducible by adequate follow-up of pregnancy; causes reducible by adequate childbirth care; causes reducible by early medical diagnosis and treatment; causes reducible by complete nutrition; causes reducible by adequate sanitation; causes reducible by decreasing maternal parity; other important reducible causes; and causes reducible by prevention ⁴.

The Wigglesworth classification modified by Keeling et al. ⁶ considered birth weight, the relationship with the circumstances of death, and the moment of care to identify the leading groups of causes of fetal and infant death.

This classification was revised and proposed as the expanded Wigglesworth classification ¹⁵; it proposes nine groups of causes of deaths, considering birth weight in relation to circumstances of death and moment of care. However, for the current study we adopted the reduced *List of Causes of Infant Mortality* (LIR-MI) used by França & Lansky ¹⁶, based on the expanded Wigglesworth classification ¹⁵, World Health Organization (WHO) ¹⁷, and Lawn et al. ¹⁸. França & Lansky ¹⁶ thus considered the groupings of causes related to maternal and antenatal factors plus respiratory diseases, totaling ten groups: prematurity; infections; asphyxia/hypoxia; congenital malformations; respiratory conditions of the newborn; pregnancy-related maternal factors; cardiorespiratory disorders originating in the perinatal period; conditions originating in the perinatal period; ill-defined causes; and other causes.

The ICE method ¹¹ used causes of death during the first year of life, but excluded stillbirths. The causes of death were combined in eight groups: congenital; asphyxia; immaturity; infection; sudden infant death syndrome (SIDS); external causes; specific conditions; and other causes ¹¹.

The SEADE Foundation method ¹² proposes classifying the causes of infant deaths as avoidable, unavoidable, and ill-defined. The group of avoidable causes is subdivided as: causes reducible by immunization; causes reducible by adequate follow-up of pregnancy; causes reducible by adequate childbirth care; causes reducible by prevention, diagnosis, and early treatment; and causes reducible through partnerships with other sectors ¹².

The *Brazilian List of Avoidable Causes of Death* was updated in 2010 by Malta et al. ¹⁹ and is divided into three sections: avoidable deaths, deaths from ill-defined causes, and other causes (deaths not clearly avoidable). Avoidable causes of death are classified in turn in four groups: reducible by immunization; reducible by adequate care for the woman in pregnancy and childbirth and for the newborn; reducible by adequate actions in diagnosis and treatment; and reducible by adequate actions in health promotion, linked to adequate healthcare actions ¹⁹. The causes reducible by adequate care for the woman during pregnancy and childbirth and for the newborn, was subdivided as: reducible by adequate care for the woman during pregnancy; reducible by adequate care for the woman during childbirth; and reducible by adequate care for the newborn ¹⁹.

Following analysis of each method, we elaborated an equivalence table for the codes of cause of death for the classifications, since there are classifications that used the ICD-9, such as those by Taucher ⁴ and ICE ¹¹, while others were based on the ICD-10 to classify the causes of deaths, such as the SEADE Foundation ¹² and the *Brazilian List of Avoidable Causes of Death* ¹⁹.

Elaboration of the diagrams and classification of deaths required standardizing the classifications of avoidability. Thus, for the classifications by Taucher ⁴, ICE ¹¹, and SEADE Foundation ¹², four categories were considered, namely: unavoidable causes, avoidable causes, ill-defined causes, and unclassified causes. The category “ill-defined causes” considered all the codes for diseases described in the classification, but it was unable to discriminate whether the death was avoidable or unavoidable. The “unclassified” category included all the codes of diseases that do not appear in the respective classifications. For the LIR-MI ¹⁶ and the *Brazilian List of Avoidable Causes of Death* ¹⁹, only three categories were used: avoidable causes, ill-defined causes, and other causes, since the authors did not use the term “unavoidable” in this classification; thus, all the codes of diseases that are not avoidable were included under “ill-defined causes”.

Finally, the study used descriptive statistical analyses with calculation of absolute and relative frequencies, using Microsoft Excel, version 2010 (Microsoft Corp., USA). The diagrams were prepared using CorelDRAW Graphics Suite X8 (Corel Corp., Ottawa, Canada).

The study was submitted to the Ethics Research Committee of the Health Sciences Center, Federal University of Espírito Santo, and was exempted from review on March 25, 2015 under number 999.562 and Certificate of Submission for Ethical Review (CAAE) number 42695015.7.0000.5060.

Results

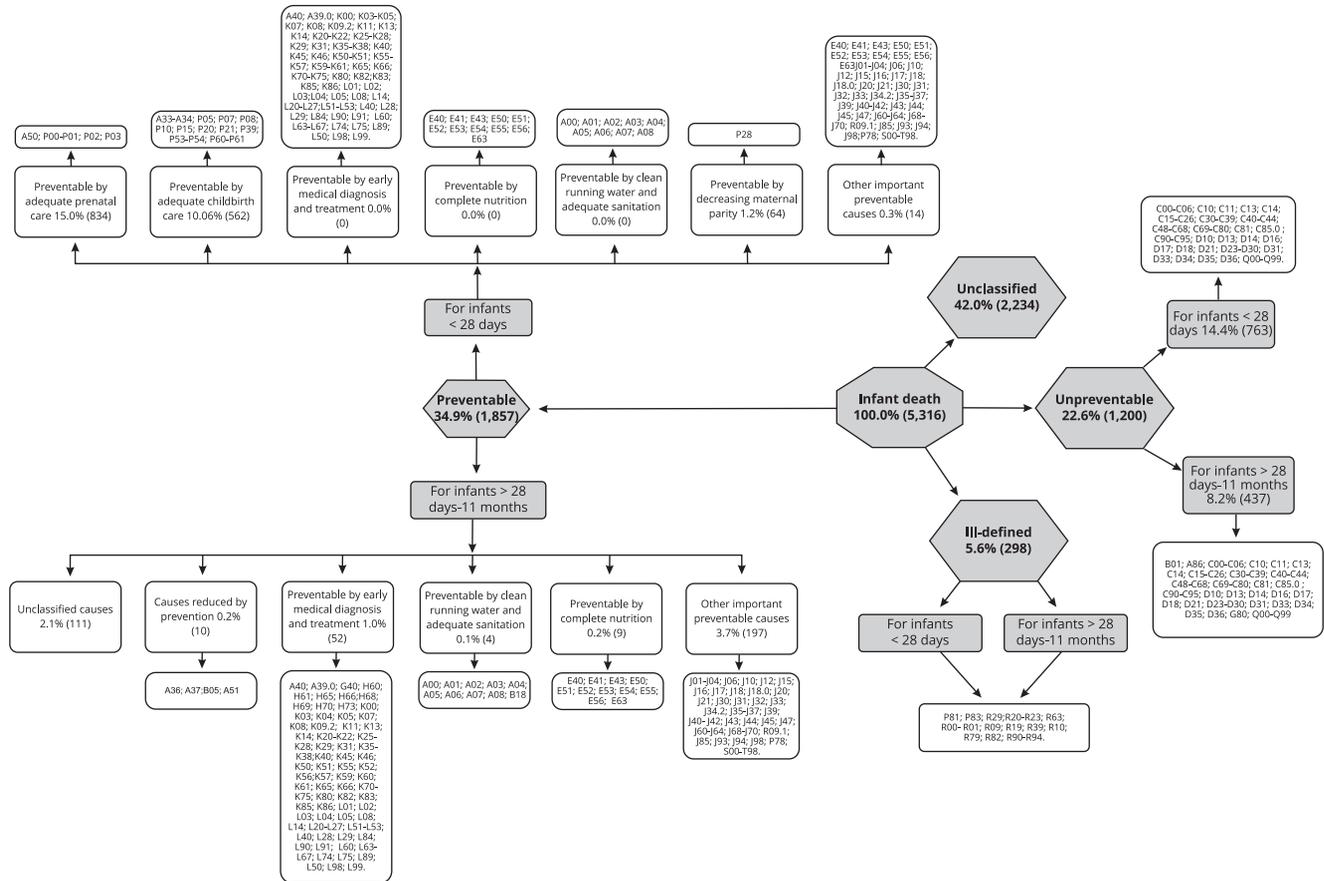
From 2006 to 2013, a total of 5,316 deaths (100%) in children less than one year of age were reported in Espírito Santo State. Analysis of the classifications of avoidability showed important differences in the composition of avoidable causes according to the different methods.

Among the classifications, ICE ¹¹ and SEADE Foundation ¹² classified the most deaths as either avoidable or unavoidable (94.6% and 94.4%, respectively). The Taucher classification ⁴ was the method with the lowest capacity to discriminate avoidability (57.5%), followed by the *Brazilian List of Avoidable Causes of Death* ¹⁹ (63.9%).

According to the criteria proposed by Taucher ⁴, 27.7% of the deaths were avoidable in the neonatal period, and of these, 15.7% occurred mainly due to causes “reducible by adequate follow-up of pregnancy” (15.7%); however, in the post-neonatal period, 7.2% were considered avoidable, with the majority of deaths concentrated in “other major reducible causes”, with 197 (3.7%) (Figure 1). Figure 2 shows the distribution of causes of death according to the LIR-MI classification ¹⁶, which classified 4,455 deaths (83.8%) as avoidable. The avoidable deaths occurred predominantly due to “congenital

Figure 1

Application of the Taucher method to the classification of infant deaths. Espírito Santo State, Brazil, 2006-2013.



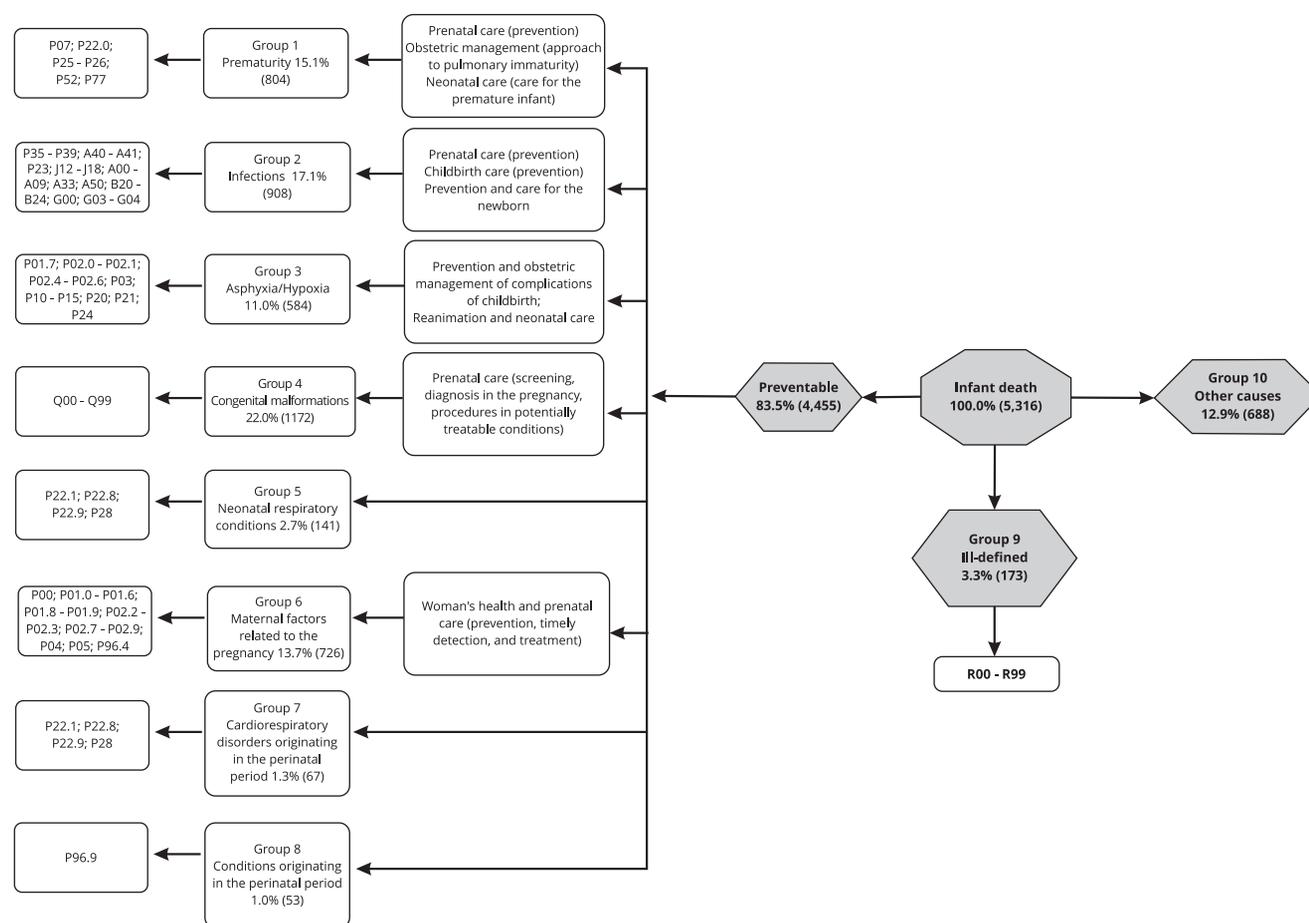
malformation” (22%), followed by deaths caused by “infections” (17.1%), both concentrated in the 3,000-3,999 gram birth weight bracket. A large number of children had not been weighed; among these, a large share of deaths were caused by “congenital malformations” (4.4%). The ICE method ¹¹, shown in Figure 3, classified 3,899 deaths (73.3%) as avoidable, the majority of which located in the group of “other causes” (39.6%), followed by “immaturity” (26.3%) and some “congenital malformations” (10.3%).

According to the classification of avoidability by the SEADE Foundation ¹², the deaths were mainly “reducible by actions in prevention, diagnosis, and early treatment” (30.6%), followed by “adequate follow-up of pregnancy” (21.9%). This classification discriminated the avoidability of 76.5% of total deaths (Figure 4). The classification of the *Brazilian List of Avoidable Causes of Death* ¹⁹ found that 3,352 deaths (63.1%) were avoidable; 1,666 of these (31.3%) were “reducible by adequate care for the newborn” and 650 (12.2%) were “reducible by adequate for the woman during pregnancy” (Figure 5).

There were a considerable number of deaths from “ill-defined” causes, especially in the classification used by the SEADE Foundation ¹² (5.6%).

Figure 2

Application of the *List of Causes of Infant Mortality (LIR-MI)* method to the classification of infant deaths. Espírito Santo State, Brazil, 2006-2013.



Discussion

High infant mortality rates in Brazil, especially neonatal mortality, require studies to evaluate the quality of obstetric care in health services. An initial step to reduce these deaths and evaluate the effectiveness of obstetric services is to identify the causes of deaths in order to classify these causes according to their avoidability and thereby pinpoint the potentially treatable causes ²⁰.

Analysis of the different methods for classifying avoidability of infant deaths is essential for orienting interventions focused on the causes of infant mortality, so as to reduce the occurrence of avoidable deaths. According to Alberman ²⁰, identifying and classifying the causes of these deaths is relevant for all countries to define and promote priority actions to prevent infant deaths. In this context, quality of care directly impacts avoidable deaths, which are considered sensitive to measures offered by health services.

Among the groups of avoidable causes, those considered "reducible by immunization" appeared in the Taucher classification ⁴, SEADE Foundation list ¹², and *Brazilian List of Avoidable Causes of Death* ¹⁹. SEADE Foundation ¹² classified the largest number of causes in this group (0.3% – 16 deaths). In the Brazilian studies that used the SEADE Foundation classification ²¹ and *Brazilian List of Avoidable*

Figure 3

Application of the *International Collaborative Effort on Infant Mortality* (ICE) method to the classification of infant deaths. Espírito Santo State, Brazil, 2006-2013.

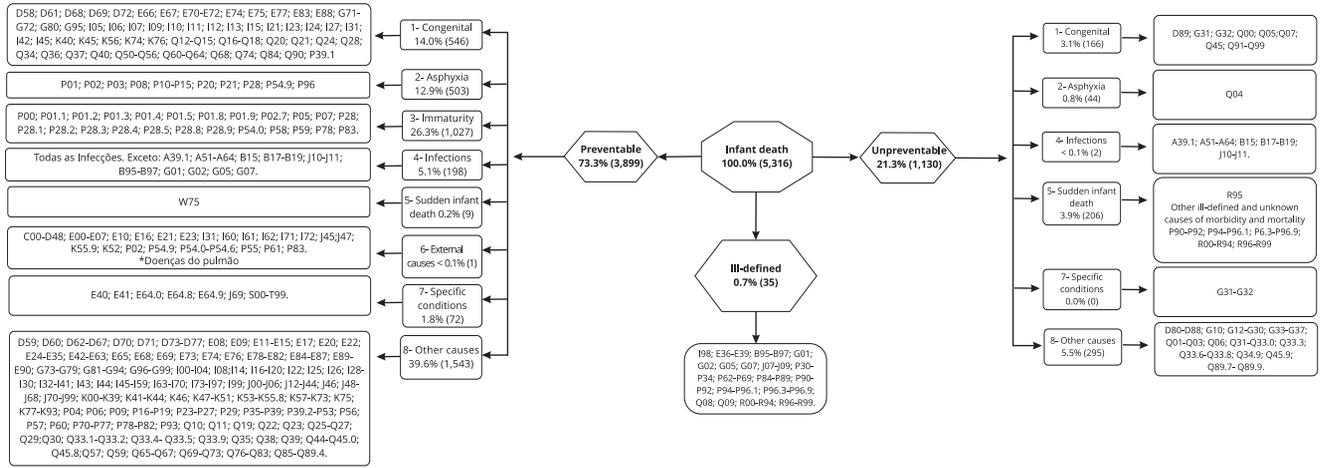


Figure 4

Application of the SEADE Foundation method to the classification of infant deaths. Espírito Santo State, Brazil, 2006-2013.

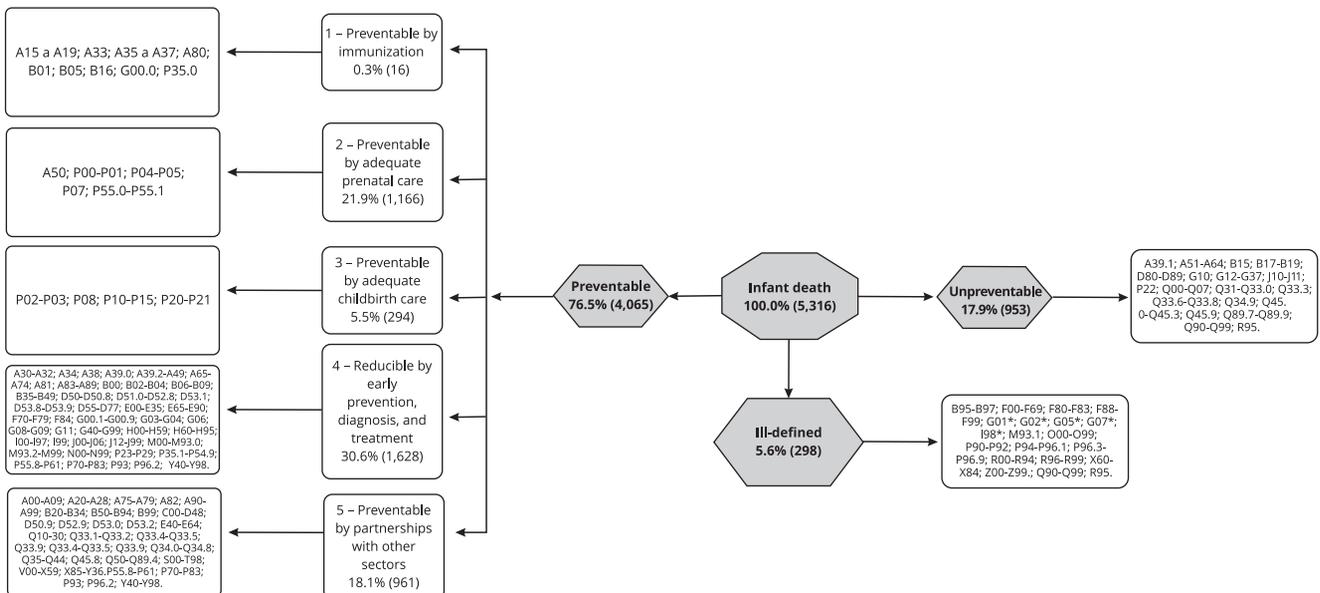
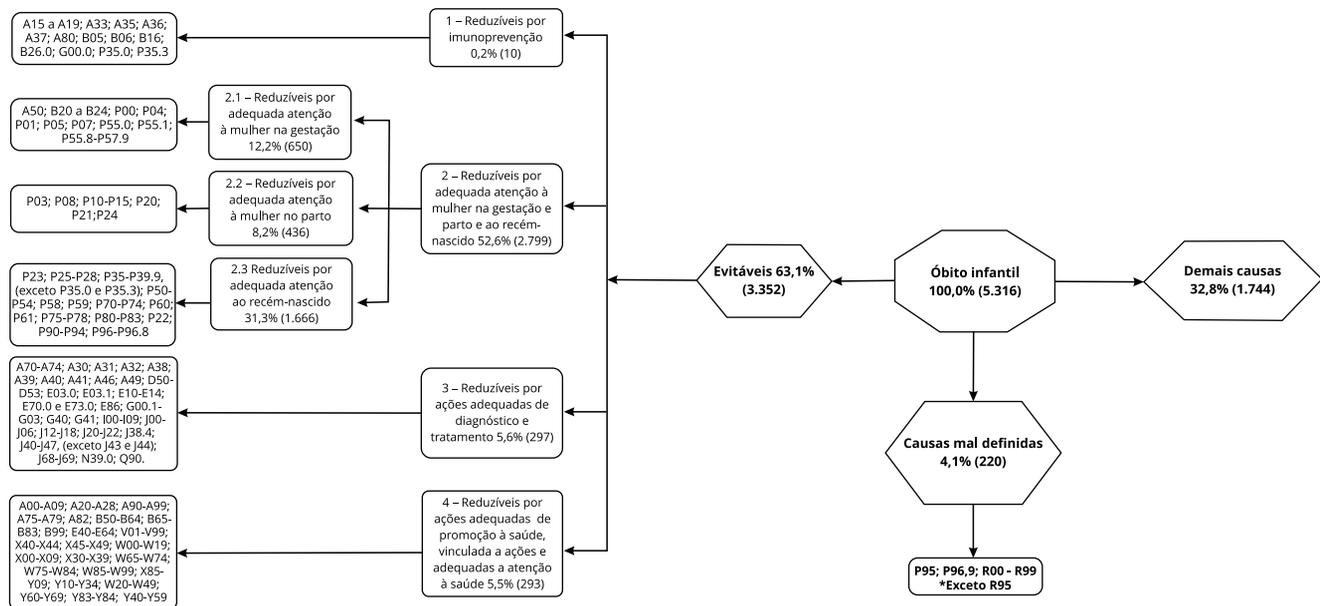


Figure 5

Application of the *Brazilian List of Avoidable Causes of Death* to the classification of infant deaths. Espírito Santo State, Brazil, 2006-2013.



Causes of Death 22, the mortality rates from causes “reducible by immunization” were very low, suggesting the effectiveness of the National Immunizations Plan since its creation, and which can be confirmed in studies on infant mortality in Brazil 23,24.

Considering the causes reducible by health promotion, all the classifications identified such deaths, except for the LIR-MI classification 16. In the Taucher classification 4, these causes appear as “reducible by complete nutrition” and “reducible by adequate sanitation”; in the ICE classification 11 the causes reducible by health promotion measures were distributed in groups called “infections”, “specific causes”, and “other causes”. However, the SEADE classification 12 and *Brazilian List of Avoidable Causes of Death* 19 each has a group to designate these causes, namely “reducible through partnerships with other sectors” and “adequate actions in health promotion, linked to adequate healthcare actions”, respectively. The SEADE Foundation 12 classified the largest number of causes in the former group (18.1% – 961 deaths).

Studies have shown major decreases in infant deaths through health promotion actions 23,25,26, explained by the increased coverage in sewage disposal and treated running water. According to estimates in Brazil, the proportion of individuals in households with inadequate water supply and inadequate sewage disposal decreased from 8.91% in 2000 to 6.12% in 2010. In Espírito Santo State, the proportion dropped from 3.54% to 0.99% during the same period (<http://www.atlasbrasil.org.br/2013/pt/consulta/>, accessed 22/Oct/2015). In addition, the inclusion of oral rehydration therapy as the responsibility of the municipalities also contributed to this drop in deaths 26,27. Buss 28 highlights that health education is a prime element for health promotion and that adequate nutritional standards and adequate housing are key components.

As for the group of causes “reducible by adequate follow-up of pregnancy”, they appeared in all the classifications, but Taucher 4 only considered these causes for neonatal deaths. The SEADE Foundation method 12 classified the most deaths from these causes (21.9% – 1,166 deaths).

Studies on prenatal care in Greater Metropolitan Vitória, Espírito Santo, identified limitations in the quality of care offered to pregnant women. The studies revealed the low quality of laboratory rest

annotations on the pregnant women's prenatal cards, suggesting that these women had not been seen by health services, or that the health services had failed to record the test results^{29,30}. In Brazil, the SUS has the responsibility for offering quality care to pregnant women and newborns, fostering the creation of bonds, dialogue, and women's active participation during the prenatal period, childbirth, and postpartum³¹. These initiatives reduce the odds of pregnant women abandoning prenatal care, contributing directly to the decrease in infant deaths from avoidable causes.

Causes "reducible by adequate childbirth care" also appeared in all the classifications. However, the LIR-MI method¹⁶ allocate these causes in groups called "asphyxia/hypoxia" and "prematurity", while ICE 11 allocates these causes in groups called "asphyxia" and "immaturity". According to these classifications, such causes are the consequences of failures in prenatal care, obstetric management, and/or deficient care for the newborn; their identification facilitates the control of infections and the prevention of iatrogenic prematurity due to early interruption of pregnancy. Thus, the ICE method¹¹ classified 39.2% of the deaths as "reducible by adequate childbirth care", while SEADE Foundation¹² classified only 5.5% of the deaths as such, reflecting unnecessary interventions in childbirth, such as the abusive use of oxytocin³² and the Kristeller maneuver³³.

The excessive and unnecessary interventions in childbirth care underscore the paradox proposed by Diniz³⁴: these interventions promote overestimation of the technology's advantages and underestimation of knowledge on the interventions' adverse effects. For example, the excessive use of cesarean sections without proper clinical indications suggests that pregnancy is being interrupted early, thus increasing the number of premature newborns. Childbirth care in Brazil can thus produce illness and death from lack of adequate technology, or it can lead to illness and death from an excess of inadequate technology³⁴.

Accordingly, Lansky et al.¹⁰ identified a high rate of interventions during childbirth in Brazil, and some of these interventions, proven to be harmful or ineffective, were cited very frequently. The use of scientifically unproven procedures during childbirth can increase the risk of death for the infant. The search for a model of care for women's and children's health with a focus on labor/childbirth, birth, and the child's growth and development from birth to 24 months is one of the objectives proposed in the most recent maternal and child health policy in Brazil, called the Stork Network (Rede Cegonha)³⁵.

Causes "reducible by diagnosis and early treatment" appeared in all the classification methods. In LIR-MI¹⁶, ICE¹², and the *Brazilian List of Avoidable Causes of Death*¹⁹, some congenital malformations are included in this group of causes, since they represent failures in screening or diagnosis of anomalies during the pregnancy. In 2013, the congenital syphilis rate for Brazil as a whole was 4.7 per 1,000 live births, while in Espírito Santo State the rate was 2.4 per 1,000 live births during the same period³⁶. Although congenital syphilis is highly preventable in the prenatal period, it is a persistent challenge in Brazil due to the services' limited capacity to intervene to reduce vertical transmission by adequately diagnosing and treating pregnant women and their partners³⁷.

Additional problems include delays in turnaround and communication of the test result for syphilis, which is only available months after the test is ordered; lack of health teams' preparedness to deal with a positive diagnosis; lack of the male partner's treatment compliance; and lack of clinical and serological follow-up of the disease by the healthcare system make congenital syphilis a public calamity in Brazil³⁷. It is thus crucial to change the health services' strategy, especially in primary healthcare services, through training, investigation, and active uptake of congenital syphilis cases. Nevertheless, studies indicate that deaths "reducible by diagnosis and early treatment" have decreased over time^{22,38}, suggesting greater access to health services by expansion of primary care.

The expansion of primary care in Brazil, mainly since implementation of the Family Health Strategy, have greatly influenced the reduction of infant mortality³⁹, especially for deaths from causes "reducible by diagnosis and early treatment", given that it has contributed to greater access to prenatal care and hospital admission. Prenatal care is indispensable, since it prioritizes care for the woman since early pregnancy, identifying and preventing various risk factors associated with the newborn's development and possible anomalies during pregnancy and consequently minimizing risk factors in childbirth and postpartum⁴⁰.

Still, challenges remain for reducing avoidable infant deaths. These challenges emerge from the low quality of care offered to the population, since health professionals are disproportionately distrib-

uted across the Brazilian territory, whereby the poorest areas have fewer health professionals; there is also high turnover of health professionals in the Family Health Strategy, mainly in difficult-to-access areas, despite the high wages, which are hardly attractive due to the precarious working conditions in public services. Thus, more investment in training health professionals may improve the quality of care, especially when there is a demand for soft technologies given the lack of diagnostic resources or simply when there is no need for use of technologies in clinical decisions (e.g., the abusive use of cesareans without proper clinical indications) ⁴¹.

As for congenital malformations, LIR-MI ¹⁶ and ICE ¹¹ classified the majority of causes as avoidable, unlike the *Brazilian List of Avoidable Causes of Death* ¹⁹, which only considers Down syndrome. Both the LIR-MI ¹⁶ and ICE classifications ¹¹ were elaborated in developed countries, suggesting that technologies in such countries are sufficient to avoid these causes of deaths. A study in Canada ⁴² identified congenital malformations as the leading cause of death using the ICE method ¹¹. Meanwhile, a study in Tanzania ⁴³ found infection as the leading cause of death, when it classified avoidability by the ICE method ¹¹. In poor countries like Tanzania, deaths from infections are prevalent, reflecting the health services' difficulty in supplying immunization. Meanwhile, even in developed countries like Canada with all the technological advances, records still show deaths from congenital malformations, since they are still difficult to prevent.

Differences in causes of deaths between countries result mainly from social determinants, specifically socioeconomic conditions. Studies show that pregnant women and children from low-income families experience more difficulty in access to health services ⁴⁴, acting as factors that can lead to infant death from preventable causes. Socioeconomic status and access to qualified health services are amenable to changes through public policies, potentially reducing the avoidable infant deaths resulting from health inequities.

In addition to the difficult-to-prevent causes, the study showed high numbers of unavoidable deaths in nearly all the classifications of avoidability. The exception was the *Brazilian List of Avoidable Causes of Death* ¹⁹, where unavoidable deaths were included in the group of "ill-defined" causes, so that it was not possible to distinguish between the two. Although unavoidable deaths occur at high rates based on the classification methods (varying from 17.2% to 22.6%), the rates have remained stable over time according to studies in Paraná State ⁴⁵ and Recife, Pernambuco ³⁸.

Among the other groups, the proportions of "ill-defined" causes were high in nearly all the classification methods. Ill-defined causes can express difficulty in access, lack of care, or precarious care, but a high proportion of such causes can compromise the quality of mortality data. However, deaths from ill-defined causes in Brazil have tended to decrease, since health policies focused on the investigation of infant deaths have been implemented throughout the country, identifying deaths that are avoidable through health promotion and timely diagnosis and treatment. This work is led by Committees for the Prevention of Infant and Fetal Death ¹⁴, for example.

Causes of deaths called "unclassified" were found in the methods by Taucher ⁴ (42%), ICE ¹¹ (4.7%), and SEADE Foundation ¹² (no death). The latter group included causes that were not incorporated into the classifications but which appeared as underlying causes of infant deaths. This shows the need for new studies to update and validate avoidability lists to include the other underlying causes of death.

Methods for classifying the avoidability of infant deaths show strengths and weaknesses that vary according to the proposed objectives. The analysis of these methods is relevant due to the differences in their methodological constructs, differences in the level of development, and conditions in access to health services in the respective countries. The LIR-MI method ¹⁶ uses birth weight as the classification criterion, which can lead to inconsistent results, since there are different ways of assigning birth weight around the world. Another limitation is the use of this classification for perinatal deaths and infant deaths from perinatal causes.

The study also showed that among the Brazilian lists, the SEADE Foundation method ¹² is able to distinguish the avoidability of causes of deaths more precisely, since it includes unavoidable causes, unlike the *Brazilian List of Avoidable Causes of Death* ¹⁹, which classifies deaths as avoidable causes, ill-defined causes, and other causes, without specifying unavoidable causes, since the classification was intended to summarize avoidable deaths according to reducibility groups. Thus, when investigating

the cause of an infant death using the Brazilian list, more deaths will likely be classified as ill-defined causes, since the classification does not distinguish unavoidable causes.

Lists of causes of deaths are an important instrument for health services performance assessment and the establishment of measures to reduce avoidable infant deaths.

Conclusion

The majority of infant deaths in Espírito Santo State, Brazil, from 2006 to 2013 were avoidable, regardless of the classification method. The results mainly highlight the quality of care for women and children during the prenatal period, labor/childbirth, and postpartum as avoidable causes of deaths. Many of these deaths were found to be unnecessary, given the simplicity of interventions required to avoid them, for example: patients' treatment adherence when the disease is diagnosed in timely fashion; lack of orientation by health services concerning the severity of the diseases; or lack of acknowledgement of severity by patients.

The lists of avoidability of infant deaths can be used as quality assessment instruments for the healthcare provided to pregnant women and newborns. However, these classifications need to be updated periodically, given the technological advances in the SUS.

To monitor the quality of these deaths requires diagnosing and recognizing the flaws in health services in order to back measures to prevent these problems. Investment in health professionals' training is an increasingly necessary measure to qualify the investigation of deaths and thereby identify and reduce the leading causes of avoidable infant deaths.

It is thus essential to evaluate the different classification methods in health services to avoid infant deaths and prevent their causes, since the use of these methods can trigger different repercussions in public health strategies, both at the local level of maternal and child healthcare and at the national and international levels in drafting health policies.

Contributors

B. A. S Dias contributed significantly to the elaboration of the content, performing the data collection and literature search and participating in the approval of the final version for publication. E. T. Santos Neto contributed significantly to the elaboration of the paper and critical revision of the content, besides participating in the approval of the final version for publication. M. A. C. Andrade contributed significantly to relevant critical revision of the intellectual content and approval of the final version for publication.

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References

1. Rutstein DD, Berenberg W, Chalmers T, Child CG, Fishman AP, Perrin EB. Measuring the quality of medical care, a clinical method. *N Engl J Med* 1976; 294:582-8.
2. Ahmad OB, Lopez AD, Inoue M. The decline in child mortality: a reappraisal. *Bull World Health Organ* 2000; 78:1175-91.
3. Lansky S, França E, Leal MC. Mortalidade perinatal e evitabilidade: revisão da literatura. *Rev Saúde Pública* 2002; 36:759-72.
4. Taucher E. La mortalidad infantil em Chile. *Notas Poblac* 1979; 7:35-72.
5. Wigglesworth JS. Monitoring perinatal mortality: a pathophysiological approach. *Lancet* 1980; 27:684-6.
6. Keeling JW, MacGillivray I, Golding J, Wigglesworth J, Berry J, Dunn PM. Classification of perinatal death. *Arch Dis Child* 1989; 64:1345-51.
7. Barros FC, Victora CG, Vaughan JP. Causas de mortalidade perinatal em Pelotas, RS (Brasil): utilização de uma classificação simplificada. *Rev Saúde Pública* 1987; 21:310-6.

8. Leite AJM, Marcopito LF, Diniz RLP, Silva AVS, Souza LCB, Borges JC et al. Mortes perinatais no Município de Fortaleza, Ceará: o quanto é possível evitar? *J Pediatr (Rio J.)* 1997; 73:388-94.
9. Fonseca SC, Coutinho ESF. Características biológicas e evitabilidade de óbitos perinatais em uma localidade do Rio de Janeiro: 1999 a 2003. *Rev Bras Saúde Matern Infant* 2008; 8:171-8.
10. Lansky S, Friche AAL, Silva AAM, Campos D, Bittencourt SDA, Carvalho ML, et al. Pesquisa Nascer no Brasil: perfil da mortalidade neonatal e avaliação da assistência à gestante e ao recém-nascido. *Cad Saúde Pública* 2014; 30 Suppl:S192-207.
11. Cole S, Hartford RB, Bergsjö P, McCarthy B. International collaborative effort on birth weight, plurality, perinatal and infant mortality. III: A method of grouping underlying causes of infant death to aid international comparisons. *Acta Obstet Gynecol Scand* 1989; 68:113-7.
12. Ortiz LP. Agrupamento das causas de morte dos menores de um ano segundo critério de evitabilidade das doenças. São Paulo: Fundação Sistema Estadual de Análise de Dados; 2000.
13. Malta DC, Duarte EC, Almeida MF, Dias MAS, Moraes Neto OL, Moura L, et al. Lista de causas de mortes evitáveis por intervenções do Sistema Único de Saúde do Brasil. *Epidemiol Serv Saúde* 2007; 16:233-4.
14. Secretaria de Vigilância em Saúde, Secretaria de Atenção à Saúde, Ministério da Saúde. Manual de vigilância do óbito infantil e fetal e do Comitê de Prevenção do Óbito Infantil e Fetal. 2ª Ed. Brasília: Ministério da Saúde; 2009.
15. Confidential Enquiry into Maternal and Child Health. Improving the health of mothers, babies and children. <http://www.cemach.org.uk> (accessed on Oct/2015).
16. França E, Lansky S. Mortalidade infantil neonatal no Brasil: situação, tendências e perspectivas. In: Rede Interagencial de Informações para Saúde, organizador. *Demografia e Saúde: contribuição para análise de situação e tendências*. Brasília: Ministério da Saúde; 2009. p. 83-112.
17. World Health Organization. Major causes of deaths among children under 5 years of age and neonates in the world, 2000-2003. http://www.who.int/child-adolescent-health/OVERVIEW/CHILD_HEALTH/map_00-03_world.jpg (accessed on Jan/2017).
18. Lawn J, Wilczynska-Ketende DK, Couzens SN. Estimating the causes of 4 million neonatal deaths in the year 2000. *Int J Epidemiol* 2006; 35:706-18.
19. Malta DC, Sardinha LMV, Moura L, Lansky S, Leal MC, Scwarzwald CL, França E, et al. Atualização da lista de causas de mortes evitáveis por intervenções do Sistema Único de Saúde do Brasil. *Epidemiol Serv Saúde* 2010; 19:173-6.
20. Alberman E. Prospects for better perinatal health. *Lancet* 1980; 2:189-92.
21. Gastaud ALGS, Honer MR, Cunha RV. Mortalidade infantil e evitabilidade em Mato Grosso do Sul, Brasil, 2000 a 2002. *Cad Saúde Pública* 2008; 24:1631-40.
22. 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* 2010; 26:481-91.
23. Simões CCS. Evolução e perspectivas da mortalidade infantil no Brasil. Rio de Janeiro: Instituto Brasileiro de Geografia e Estatística; 1999.
24. Costa MCN, Mota ELA, Paim JS, Silva LMV, Teixeira MG, Mendes CMC. Mortalidade infantil no Brasil em períodos recentes de crise econômica. *Rev Saúde Pública* 2003; 37: 699-706.
25. Bezerra Filho JG, Pontes LR, Miná DD, Barreto ML. Infant Mortality and sociodemographic conditions in Ceará, Brazil, 1991 and 2000. *Rev Saúde Pública* 2007; 41:1023-31.
26. Galvão CES, Silva AAM, Silva RA, Reis Filho SAR, Novochadlo MAS, Campos GJV. Terapia de reidratação oral para diarreia aguda em região do nordeste do Brasil, 1986-1989. *Rev Saúde Pública* 1994; 28:416-422.
27. Victora CG. Mortalidade por diarreia: o que o mundo pode aprender com o Brasil? *J Pediatr (Rio J.)* 2009; 85:3-5.
28. Buss PM. Promoção da saúde e qualidade de vida. *Ciênc Saúde Coletiva* 2000; 5:163-78.
29. Santos Neto ET, Oliveira AE, Zandonade E, Gama SGN, Leal MC. O que os cartões de pré-natal das gestantes revelam sobre a assistência nos serviços do SUS da Região Metropolitana da Grande Vitória, Espírito Santo, Brasil? *Cad Saúde Pública* 2012; 28:1650-62.
30. Polglioni RBS, Santos-Neto ET, Zandonade E. Informações dos cartões de gestantes e dos prontuários da atenção básica sobre assistência pré-natal. *Rev Bras Ginecol Obstet* 2014; 36:269-75.
31. Área Técnica de Saúde da Mulher, Secretaria de Políticas de Saúde, Ministério da Saúde. Parto, aborto e puerpério: assistência humanizada à mulher. Brasília: Ministério da Saúde; 2001.
32. Clark SL, Simpson KR, Knox E, Garite TJ. Oxytocin: new perspectives on an old drug. *Am J Obstet Gynecol* 2009; 200:35.e1-6.
33. Berghella V, Baxter JK, Chauhan SP. Evidence-based labor and delivery management. *Am J Obstet Gynecol* 2008; 199:445-54.
34. Diniz SG. Gênero, saúde materna e o paradoxo perinatal. *Rev Bras Crescimento Desenvol Hum* 2009; 19:313-26.

35. Ministério da Saúde. Portaria nº 1.459, de 24 de junho de 2011. Institui, no âmbito do Sistema Único de Saúde – SUS – a Rede Cegonha. http://bvsmms.saude.gov.br/bvs/saudelegis/gm/2011/prt1459_24_06_2011.html (accessed on Oct/2015).
36. Ministério da Saúde. Boletim Epidemiológico Sífilis 2015; Ano IV, n. 1.
37. Domingues RMSM, Leal MC. Incidência de sífilis congênita e fatores associados à transmissão vertical da sífilis: dados do estudo Nascer no Brasil. *Cad Saúde Pública* 2016; 32:e00082415.
38. Nascimento SG, de Oliveira CM, Sposito V, Ferreira DK, do Bonfim CV. Mortalidade infantil por causas evitáveis em uma cidade do Nordeste do Brasil. *Rev Bras Enferm* 2014; 67:208-12.
39. Macinko J, Guanais FC, Souza MF. Evaluation of the impact of the Family Health Program on infant mortality in Brazil, 1990-2002. *J Epidemiol Community Health* (1979) 2006; 60:13-9.
40. Wehby GL, Murray JC, Castilla EE, Lopez-Camelo JS, Ohsfeldt RL. Prenatal care effectiveness and utilization in Brazil. *Health Policy Plan* 2009; 24:175-88.
41. Victora CG, Aquino EML, Leal MC, Monteiro CA, Barros FC, Szwarcwald CL. Maternal and child health in Brazil: progress and challenges. *Lancet* 2011; 377:1863-76.
42. Liu L, Johnson H, Cousens S, Perin J, Scott S, Lawn JE, et al. Global, regional and national causes of child mortality in 2000-2010: an updated systematic analysis. *Lancet* 2002; 379:2151-61.
43. Hinderaker SG, Olsen BE, Bergsjø PB, Gasheka P, Lie RT, Havnen J, et al. Avoidable still births and neonatal deaths in rural Tanzania. *BJOG* 2003; 110:616-23.
44. Jobim R, Aerts D. Mortalidade infantil evitável e fatores associados em Porto Alegre, Rio Grande do Sul, Brasil, 2000-2003. *Cad Saúde Pública* 2008; 24:179-87.
45. Mathias TAF, Assunção AN, Silva GF. Infant deaths investigated by the Prevention Committee of Infant Mortality in region of Paraná state. *Rev Esc Enferm USP* 2008; 42:445-53.

Resumo

O objetivo foi comparar a evitabilidade dos óbitos infantis e analisar os grupos de redutibilidade segundo os métodos de classificação. Estudo descritivo comparativo, realizado entre 2006 e 2013, no Espírito Santo, Brasil, por meio da classificação de 5.316 óbitos infantis, de acordo com cinco métodos de evitabilidade diferentes. Os métodos International Collaborative Effort on Infant Mortality (ICE) e a Fundação SEADE foram capazes de classificar a maior quantidade de óbitos em evitáveis e não evitáveis, respectivamente, 94,6% e 94,4%. Ressalta-se que a maioria das mortes foi em consequência de falhas na atenção ao pré-natal, ao parto e ao puerpério, independentemente do método de evitabilidade aplicado. Além disso, observou-se considerável número de óbitos ocorridos por causas “mal definidas” em todos os métodos, sugerindo a dificuldade de acesso ou assistência precária dos serviços de saúde. Nota-se que o emprego dos métodos de evitabilidade consiste em um importante instrumento para o diagnóstico das falhas de desempenho dos serviços de saúde e a orientação de medidas para reduzir os óbitos infantis evitáveis. Portanto, o fortalecimento da assistência materno-infantil, o investimento em treinamentos e a capacitação dos profissionais de saúde configuram-se como foco prioritário para o avanço de políticas públicas direcionadas à redução da mortalidade infantil.

Saúde Materno-Infantil; Mortalidade Infantil;
Causas de Morte

Resumen

El objetivo fue comparar la evitabilidad de los óbitos infantiles y analizar los grupos de reducibilidad, según los métodos de clasificación. Se trata de un estudio descriptivo comparativo, realizado entre 2006 y 2013, en Espírito Santo, mediante la clasificación de 5.316 óbitos infantiles, de acuerdo con cinco métodos de evitabilidad diferentes. Los métodos International Collaborative Effort on Infant Mortality (ICE) y la Fundación SEADE fueron capaces de clasificar la mayor cantidad de óbitos en evitables y no evitables, respectivamente, 94,6% y 94,4%. Se resalta que la mayoría de las muertes fueron consecuencia de errores en la atención al pre-natal, al parto y al puerperio, independientemente del método de evitabilidad aplicado. Asimismo, se observó un considerable número de óbitos ocurridos por causas “mal definidas” en todos los métodos, sugiriendo la dificultad de acceso o asistencia precaria de los servicios de salud. Se nota que el empleo de los métodos de evitabilidad consiste en un importante instrumento para el diagnóstico de los errores de desempeño de los servicios de salud y la orientación de medidas para reducir los óbitos infantiles evitables. Por tanto, el fortalecimiento de la asistencia materno-infantil, la inversión en prácticas y la capacitación de los profesionales de salud se configuran como un foco prioritario para el avance de políticas públicas dirigidas a la reducción de la mortalidad infantil.

Salud Materno-Infantil; Mortalidad Infantil;
Causas de Muerte

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