Research note

Use of linkage to analyze completeness and concordance of deaths from congenital syphilis in the Metropolitan Region of São Paulo, Brazil, 2010-2017: a descriptive study

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Abstract

Objective: To evaluate the completeness and concordance of infant deaths from congenital syphilis in the Metropolitan Region of Sao Paulo, Brazil, between 2010 and 2017. **Methods:** This was a descriptive study based on linkage between the Mortality Information System (SIM) and the Live Birth Information System (SINASC). Deaths with mention of congenital syphilis in multiple causes of death were analyzed. The completeness of 11 SIM variables was analyzed and SINASC was adopted as the reference. The Kappa statistic was used to analyze concordance. **Results:** There were 134 recorded congenital syphilis deaths, 132 of which were linked. 67 had congenital syphilis as the underlying cause, while 65 involved multiple causes of death, indicating underestimated congenital syphilis mortality. After linkage, the number of variables with excellent completeness increased from two to ten. **Conclusion:** Linking SIM with SINASC data improved completeness. The magnitude of congenital syphilis mortality was found to be underestimated, and the use of multiple causes improved its measurement.

Keywords: Syphilis, Congenital; Infant Mortality; Cause of Death; Information Systems; Epidemiology, Descriptive.

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Introduction

Congenital syphilis results from the transmission of *Treponema pallidum* from a pregnant woman to her baby.[1] Untreated or inadequate treatment of infected pregnant women can lead to complications such as early fetal death, neonatal death, premature birth, and congenital infection in infants.[2]

> *The quality of health information systems can ensure the reliability of data for informing actions to improve Public Health.*

Although it is an easily preventable and treatable disease, congenital syphilis is the second most common infectious cause of stillbirth worldwide.[3] In Brazil, mortality due to congenital syphilis increased 431% in the period 2008-2018, reaching 8.2 per 100,000 live births.[1] These deaths represent an undesirable event in Public Health, since they are preventable.

Quality health information systems are needed in order to be able to act to reduce these deaths. The proper maintenance of these systems is important to ensure data reliability and to support actions that improve Public Health.[4,5]

The objective of this study was to evaluate the completeness and concordance of infant deaths from congenital syphilis in the Metropolitan Region of Sao Paulo, Brazil, between 2010 and 2017.

Methods

This was a descriptive study of infant deaths due to congenital syphilis in the Metropolitan Region of São Paulo city. This is an important economic region, with 20,996,747 inhabitants and responsible for 53.8% of the gross domestic product (GDP) of the entire state of São Paulo.[6] Between 2007 and 2018, this region recorded 57.3% of the state's congenital syphilis cases.[7]

We included deaths of children under 1 year old, between 2010 and 2017, for which congenital syphilis (codes A50.0-A50.9 of the Tenth Revision of the International Statistical Classification of Diseases and Related Health Problems - ICD-10) was mentioned in the multiple cause of death lines of their death certificates.

We used data from the Mortality Information System (SIM) and the Live Birth Information System (SINASC), obtained from the Brazilian National Health System Information Technology Department (DATASUS) website (accessed on October 23, 2020) and from the São Paulo State Health Department Center for Strategic Health Information (CIEVS/SES/SP).[8]

The following SIM and SINASC variables were analyzed:

a) Sociodemographic variables: sex; race/skin color; maternal schooling; mother's usual occupation; maternal age.

b) Pregnancy and childbirth: gestational age (weeks); birth weight; type of pregnancy; type of delivery; number of live born children; number of stillborn children (fetal losses/miscarriages).

The deaths identified were linked to the live birth data using the deterministic linkage technique, which identifies the same individual in different databases. The first stage of this process was carried out by means of the common unifying variable, 'live birth certificate number', available in the databases obtained from DATASUS. The second step was carried out by CIEVS/SES/SP, which used the 'name of the deceased', 'date of birth' and 'mother's name' identification variables to identify the live birth certificate number, with manual checking of pairs.

Completeness was measured by the proportion of completed variables, excluding blank and unknown records, according to the following criteria: excellent (>95.0%); good (90.1-95.0%); fair (80.1-90.0%); poor (50.1-80.0%); and very poor (≤50.0%).[9] The live birth certificate was used as the reference to check whether the information had been added to the death certificate.

The difference in completeness was analyzed according to the death certificate issuer: hospital physician (attending or on duty) and physician from other services (Medical Examiner-Coroner; Death Verification Service; other services).

Concordance analysis allows us to identify whether the filling out of a given variable has been done identically on both databases. The proportion of concordant records was calculated for the categorical variables common to the live birth certificates and the death certificates, and the Kappa statistic was used according to the following criteria: no agreement (<0); poor agreement (0.00-0.19); reasonable agreement (0.20-0.39); moderate agreement (0.40-0.59);

substantial agreement (0.60-0.79); and excellent agreement (0.80-1.00).[10]

The data were processed using SPSS17.0 and Microsoft Excel 2016.

The study project was approved by the University of São Paulo Faculty of Public Health Research Ethics Committee: Certificate of Submission for Ethical Appraisal No. 17870819.1.0000.5421; Opinion No. 3.525.067, issued on August 22, 2019.

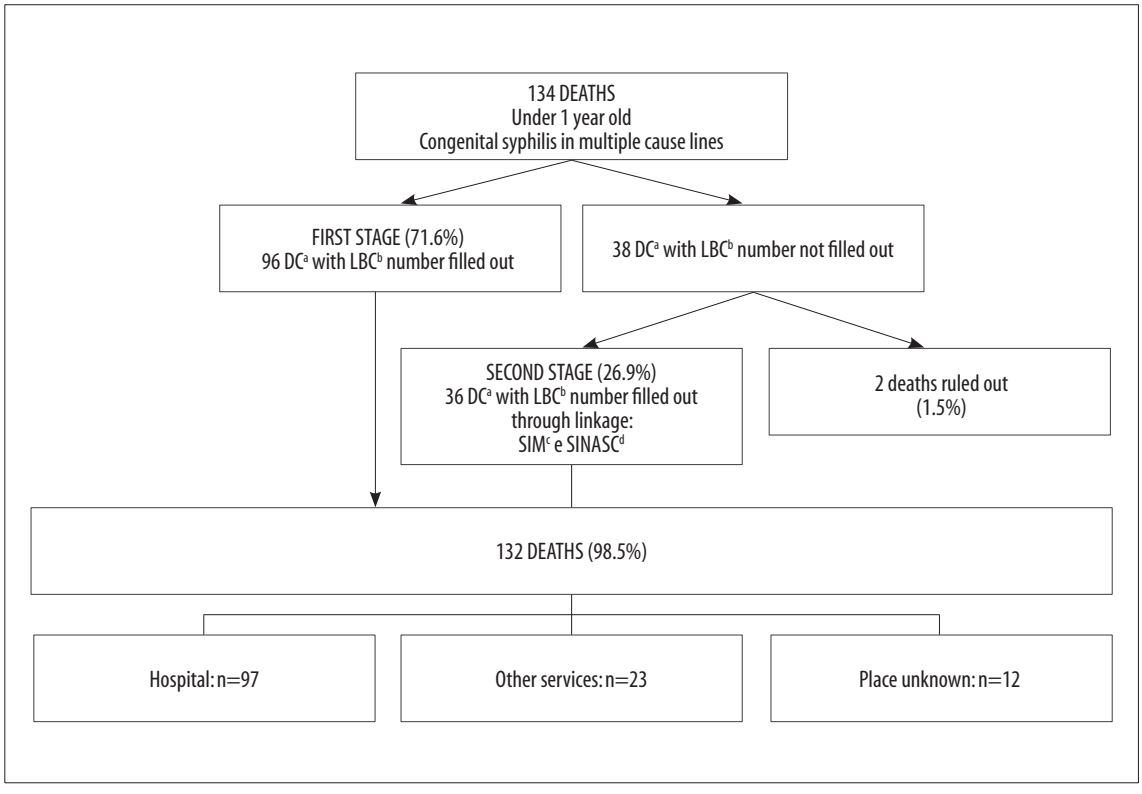
Results

We identified 134 deaths due to congenital syphilis, 132 (98.5%) of which were linked to the SINASC system. In the first stage of the study, 96 deaths (71.6%) were paired with live birth certificates, plus a further 36 (26.9%) in the second stage. Two unlinked deaths (1.5%) were excluded (Figure 1).

Initially, 54 deaths were recorded as having congenital syphilis as their original underlying cause. After analyzing the (final) 'underlying cause' field, a further 13 deaths (24.1%) were added, totaling 67. After analyzing multiple causes, a further 65 deaths (+97.0%) were added, totaling 132.

Of the 132 death certificates, the 'issuer' field was complete on 120 of them, 97 (80.8%) of whom were hospital physicians and 23 physicians from other services. Most of the variables were more complete on the death certificates issued by the hospitals. It is noteworthy that before linkage, two variables had excellent completeness; and five variables had good completeness. After linkage with SINASC, the excellent variables increased from two to ten. 'Maternal schooling', 'birth weight' and 'number of stillborn children' were the variables that had the highest increase in information (>10.0%) (Table 1).

When analyzing concordance, the Kappa statistic was poorest for race/skin color (0.49), occupation (0.46) and maternal schooling (0.52) (Table 2).



a) DC: Death Certificate; b) LBC: Live Birth Certificate; c) SIM: Mortality Information System; d) SINASC: Live Birth Information System.

Figure 1 – Diagram showing identification of infant deaths due to congenital syphilis, Metropolitan Region of São Paulo, Brazil, 2010-2017

Table 1 – Completeness of Death Certificate variables before and after linkage for children who died of congenital syphilis (n=132), Metropolitan Region of São Paulo, Brazil, 2010-2017

Variables	Before linkage				Linkage			
	Hospital (n=97)		Other services (n=23)		Before		After	
	n	%	n	%	n (%)	Score	n (%)	Score
Sexo	97	100.0	23	100.0	132 (100.0)	E[a]	132 (100.0)	E
Race/skin color	92	94.8	23	100.0	125 (94.7)	G[b]	132 (100.0)	E
Birth weight	90	92.8	16	69.6	117 (88.6)	RE[c]	132 (100.0)	E
Maternal schooling	85	87.6	20	87.0	113 (85.6)	RE	131 (99.2)	E
Maternal occupation	19	19.6	2	8.7	24 (18.2)	V[d]	24 (18.2)	V
Maternal age	89	91.8	21	91.3	120 (90.9)	G	132 (100.0)	E
Gestational age (weeks)	93	95.9	19	82.6	123 (93.2)	G	130 (98.5)	E
Type of pregnancy	95	97.9	20	87.0	126 (95.5)	E	132 (100.0)	E
Type of delivery	94	96.9	20	87.0	125 (94.7)	G	132 (100.0)	E
Number of live born children	89	91.8	20	87.0	119 (90.2)	G	129 (97.7)	E
Number of stillborn children	84	86.6	19	82.6	113 (85.6)	RE	128 (97.0)	E

a) E: Excellent (>95.0%); b) G: Good (90.1 to 95.0%); c) RE: Regular (80.1 to 90.0%); d) V: Very poor (≤50.0%).

Table 2 – Concordance between variables common to the Mortality Information System (SIM) and the Live Birth Information System (SINASC) with complete records and Kappa statistic, Metropolitan Region of São Paulo, Brazil, 2010-2017

Variables	No. of records	Kappa	Classification	P-value
Sex	132	0.97	Excellent	<0.001
Race/skin color	132	0.49	Moderate	<0.001
Maternal schooling	131	0.52	Moderate	<0.001
Maternal occupation	27	0.46	Moderate	<0.001
Pregnancy	130	0.77	Substantial	<0.001
Type of pregnancy	132	0.62	Substantial	<0.001
Type of delivery	132	0.85	Excellent	<0.001

Discussion

The completeness of SIM system data was enhanced through linkage with the SINASC system. Death certificates were filled out better at hospitals, and concordance was excellent or moderate for most variables. Significant underestimation of mortality due to congenital syphilis was only identified when the underlying cause of death was analyzed.

A limitation of the study is the possibility of congenital syphilis not being mentioned on the death certificate, especially in the case of deaths that occurred later, due to failure to identify the disease at childbirth or due to lack of follow-up after hospital discharge, which may have led to under-recording of this cause. All possibly infected newborns should be investigated with complementary tests for congenital syphilis until they are negative, since most are asymptomatic at birth.

All fields referring to multiple causes of death were used, for all diseases, morbid states, and injuries that contributed to or produced the death.[11] This criterion allowed us to identify that congenital syphilis was not classified as the underlying cause in half of the deaths for which the disease was present in the causal chain

leading to death. Analyzing only the underlying cause would result in around half of the infant deaths due to congenital syphilis being underestimated. A study conducted using the same strategy found 25.0% additional deaths for Brazil as a whole, in 2001/2002 and 2012/2013.[12] Selecting the underlying cause of death alters the magnitude of some diseases, and analyzing this cause alone underestimates the magnitude of congenital syphilis mortality.[13]

Under-recording can be minimized by means of investigations carried out by Infant Death Surveillance Committees. This study found that the work of these committees increased identification of these deaths by 24.0%; in a similar study conducted in Recife in 2014, 63.9% of investigated deaths had their underlying cause redefined.[14]

Use of the linkage technique allows for an increase in the quantity and quality of information, in addition to it being easy to perform and its low operational cost.[15] The success of its use depends on good data coverage and quality, so that correct identification of the same individual in different databases can occur. An excellent percentage of linkage was obtained, reflecting the excellent coverage and regularity rates of the SIM and SINASC systems in the Metropolitan Region of São Paulo, as well as improvements in the filling out of the single identifier (live birth certificate number) for infant deaths.

Analysis of the completeness of variables is important for evaluating the quality of vital statistics, because incomplete data can generate distortions and biases in health indicators.[16] It is necessary to reinforce training and raise awareness among physicians about the importance of filling out death certificates as a generator of epidemiological information.

Linking deaths with the SINASC system increased the filling out of variables common to both systems, allowing for improved analysis of maternal characteristics. This is consistent with the results of other studies.[15] The recovery of information on maternal education is noteworthy, as its completeness increased from regular to excellent. Low schooling is a factor associated with infant mortality and incidence of syphilis among pregnant women.[17,18]

Death certificates filled out by hospital physicians were more complete, probably because of access to information on hospital medical records, which is not the case for Medical Examiner-Coroner/Death Verification Service physicians. A study of fetal deaths in the city of São Paulo, in 2008, also found better completion of death certificates issued by hospitals.[19]

The concordance results indicate an improvement in the quality of death data and reaffirm the usefulness of these systems as instruments for measuring the health status of children.[20] However, the race/skin color variable showed the poorest concordance, possibly due to the fact that the color of the newborn child is reported by its mother while the color of a deceased person is reported by someone else. In Brazil, race/skin color is a social construct, associated with socioeconomic and health inequalities, including infant mortality, which makes it even more important to fill out this field properly.[21,22]

Although the SIM system has improved over the years, the need exists to improve the selection of the underlying cause in deaths due to congenital syphilis and maintain continuous evaluation of its quality in order to obtain reliable indicators. Incidence of congenital syphilis, as well as incidence of deaths due to it, has been increasing continuously, and quality information is an important tool in the efforts to reduce it.[23]

Authors' contributions

Almeida ABM and Silva ZP contributed to the concept and design of the study. Almeida ABM drafted preliminary versions of the manuscript and analyzed and interpreted the data. Silva ZP contributed to data analysis and interpretation and critically reviewed the manuscript. Both authors have approved the final version and are responsible for all aspects of the study, including the guarantee of its accuracy and integrity.

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