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Deaths of women hospitalized for childbirth and abortion, and of their concept, in maternity wards of Brazilian public hospitals

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Abstract *The aim of this cross-sectional hospital-based study of 7,845 pregnancies was to analyze deaths of women hospitalized for childbirth and abortion, and fetal and neonatal deaths, in public hospitals in the cities of São Paulo, Rio de Janeiro and Niteroi (RJ), Brazil, in 2011. Outcomes of the pregnancies were: one maternal death, 498 abortions, 65 fetal deaths, 44 neonatal deaths and 7,291 infant survivors. Data were collected through interviews, medical records and the women's pregnancy records, and from the Mortality Information System (SIM). The study population was described and kappa coefficients of causes of death (from the SIM, and certified by research) and mortality health indicators were estimated. The maternal mortality ratio was 13.6 per 100,000 live births (LB), the fetal death rate was 8.8‰ births and the neonatal mortality rate was 6.0‰ LB. The drug most used to induce abortion was Misoprostol. The main causes of fetal and neonatal deaths were respiratory disorders and maternal factors. Congenital syphilis, diabetes and fetal death of unspecified cause were under-reported in the SIM. Kappa coefficients by chapter were 0.70 (neonatal deaths) and 0.54 (stillbirths). Good quality care in reproductive planning, prenatal care, during labor and at birth will result in prevention of deaths.*

Key words *Abortion, Fetal death, Neonatal mortality, Maternal mortality, Cause of death*

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Introduction

Women and their concepti are a group with higher vulnerability, expressed by the risk of illness and death[1], the biological determinants of which are exacerbated by socio-economic characteristics and factors in healthcare[2].

Maternal death is a rare, tragic and avoidable event[3]. In 2013, in spite of the progress in maternal-infant health in Brazil, the maternal mortality ratio was 58.1 per 100,000 live births[4], not achieving the 75% reduction that is the fifth target in the Millennium Development Goals[5].

For the conceptus, the risk of death is greater at the beginning of the pregnancy, when the pregnancy itself has not even been recognized or diagnosed[6]. These miscarriages, frequently reported as irregularities of menstruation, are not usually reported[6].

The frequency of abortions is also imprecise, even in countries where it is legalized[7]. In 2010, the National Abortion Survey estimated that 15% of Brazilian women, by the completion of their reproductive life, had had an abortion, requiring hospitalization in 50% of those cases[8]. In spite of the reduction of 26% in the indirect national estimates of induced abortions in women of fertile age from 1995 to 2013, their magnitude is a source of concern[9].

What defines whether losses of the fetus are abortions or fetal deaths are the limits established for analysis in relation to birth weight, gestation age or length of the conceptus[10]. Brazil adopts the definition of the International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD), which proposes the following cut-off values for fetal death: weight at birth, 500 grams; gestation age, 22 weeks; and length, 25 cm[10]. Lawn et al.[11] recommend that the definition of fetal death, for international comparisons, should use gestation age (28 or more weeks), and propose this change in the 11th ICD. Fetal death is little understood and studied; it was not included in the Millennium Development Goals, and is practically invisible in world political agendas[11]. However, the rates continue to be high, especially in the countries of low and medium income: the average rate in these countries is estimated to be 28.9 fetal deaths per 1,000 births, varying from 13.6 in Argentina to 56.5, in Pakistan[12]. In 2014, the 67th World Health Assembly established as a target the reduction of fetal death to 12 or less per 1,000 births in 2030[11].

For live births, the risk of infant death is greatest immediately after the transition to extra-uterine life, and decreases markedly during the first week of life[5,6,13]. Considering the similarity of the causes of death and the risk factors in fetal deaths and early neonatal deaths, a variation in the quality of statement in the death certificate is not expected, but systematic errors generate a lesser quality of information for fetal deaths[14]. Incompleteness, and low reliability and validity of the causes of death for neonatal and fetal deaths, principally, have been reported in Brazilian studies[15-18].

On the one hand technological advances in healthcare for pregnancy and the neonatal period have brought positive results for perinatal health, on the other hand they have accentuated the inequality in which access to technology is not universal or equitable[19]. Inequalities in healthcare and socio-demographic inequalities are risk factors common to induced abortions[20], fetal deaths[15], neonatal deaths[13] and maternal deaths[3].

Hypertension and hemorrhage have been the most frequent causes of maternal death in Brazil, and analysis of the causes of neonatal and fetal deaths shows maternal morbidities as a growing cause[4,18], indicating the interrelationship between these deaths and the interventions necessary for their reduction. During the prenatal period, deaths of mothers and their concepti[21] can be prevented by screening for and treatment of morbidities such as syphilis, diabetes, high blood pressure[22], and by the ability to detect and handle obstructed labor, and reduction of medicalization at the moment of birth.

The objective of this study was to analyze, in maternity facilities of Brazil's Single Health System (*Sistema Único de Saúde*), maternal deaths, abortions, and fetal and neonatal deaths, in the cities of São Paulo, Rio de Janeiro and Niteroi (Rio de Janeiro State) in 2011, with an emphasis on the causes of deaths.

Methodology

A sectional study was carried out, over 3 months in the second half of 2011, in maternity facilities in Brazil's Single Health System with large numbers of births: four facilities in the city of São Paulo, in São Paulo State ('the SP center'); and in Rio de Janeiro State ('the RJ center'), one in Niteroi and one in Rio de Janeiro city. The deaths in hospital that took place during pregnancy, in birth and until discharge from hospital were identified, first, in the fieldwork, and subsequently, by probabilistic record linkage of the research

database to the Brazilian Mortality Information System (SIM): (i) in São Paulo, by the Program for Improvement of Mortality Data (PRO-AIM) of the Prefecture of the municipality of São Paulo; and (ii) in Rio de Janeiro and Niteroi, by the Rio de Janeiro State Health Department. The computer program RecLink3[23] was used. Losses in the study were less than 5%.

Interviews were held with the women 12 hours after birth, and 5 hours after abortion, and hospital medical records, the pregnant mother's records and the records of the delivery room – made by nurses and previously trained healthcare students – were consulted.

Study population

Figure 1 shows the flow diagram of the population of the study in relation to the situations of the women and their concepti.

7,845 women were interviewed (5,955 in São Paulo center and 1,890 in Rio de Janeiro center). There were four deaths of women in the SP center, one of a mother after transfer to another facility, and three after discharge, in the late puerperium for reasons not related to the maternity cycle, and not computed as maternal deaths. These deaths were investigated by the Municipal Maternal, Fetal and Infant Death Committee (CMMIF) of São Paulo. No women died in the RJ center.

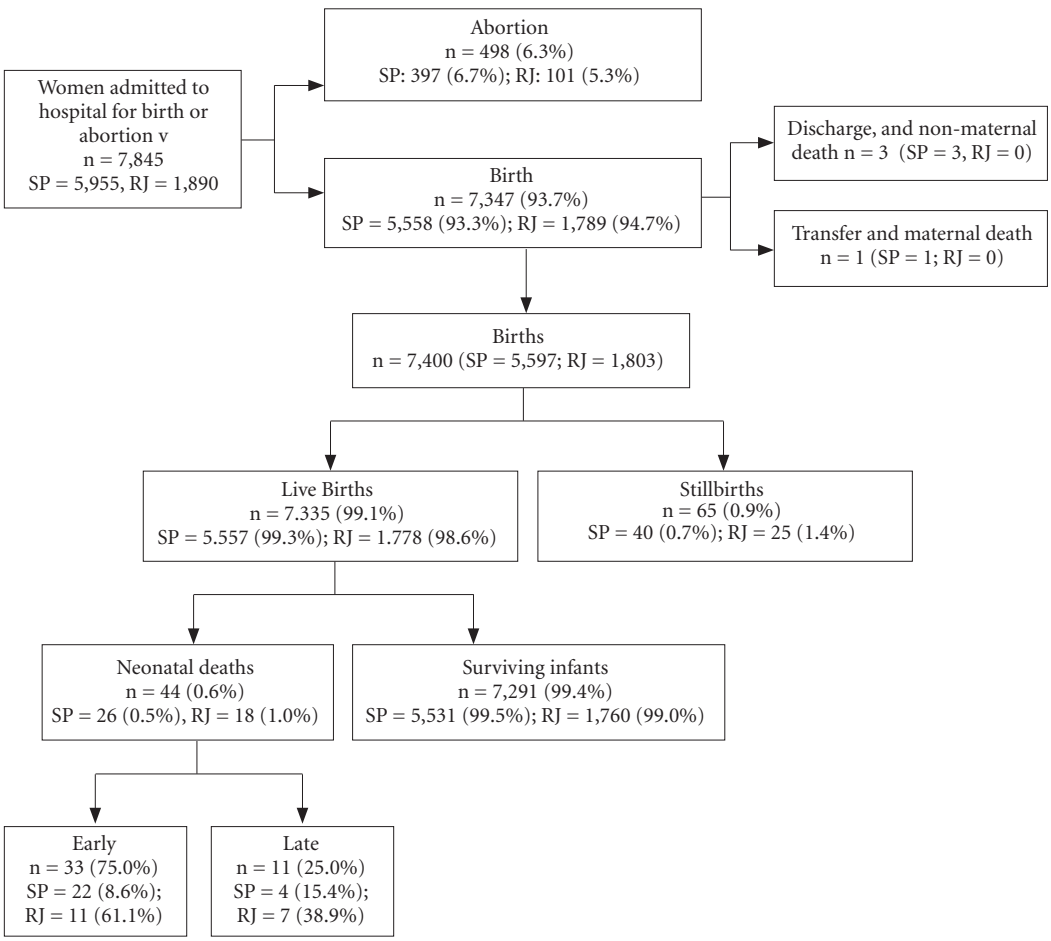

Figure 1. Flow diagram of women and concepti, public maternity facilities of the cities of São Paulo (SP center), and Rio de Janeiro and Niterói (RJ center), Brazil, 2011.

Fetal deaths and neonatal deaths were analyzed as to time of occurrence: abortions and fetal deaths as to < 22 and ≥ 22 weeks of gestation, respectively, and infant deaths from 0-27 days[10]. In spite of the definition of fetal deaths (death of a product of conception, before complete expulsion or extraction from the body of the mother, whatever the duration of pregnancy)[10], we adopted *fetal death* to represent the fetal component of perinatal mortality[10], for the purpose of comparison with other studies. An abortion was reclassified as a stillbirth. From visual sources it was possible to identify the infant deaths that took place after the survey, and thus the survivors of the infancy period (364 complete days of life). 26 infant deaths that took place after the discharge from hospital were not analyzed, due to the impossibility of access to the medical records for certification of a new Death Certificate. These deaths were excluded from the analysis of the group of survivors. Of the total of 7,898 concepti, 563 fetal losses were analyzed (498 abortions and 65 fetal deaths), 44 neonatal deaths (33 early and 11 late), and 7,291 surviving infants.

The frequencies of deaths of the concepti were presented according to the moment of death. Abortions were described according to the type (without expulsion of the fetus; spontaneous; intentional, under law or court order; and induced) and by the means used for induced abortions. Fetal and neonatal deaths informed by the SIM were described according to the confirmation by the researchers.

Concepti were described according to the center where the birth or abortion occurred (SP center; RJ center), and maternal socio-demographic characteristics, including age range (< 20; 20-34; ≥ 35 years), schooling (< 8; ≥ 8 years of schooling) and self-reported skin color ('white'; 'brown; 'black'; others), characteristics of the reproductive and pregnancy history, such as number of previous births (none, 1-2 and 3 or more); previous abortion (yes; no; not applicable), previous stillbirths (yes; no; not applicable); and, in binary form (yes; no): self-reported morbidities during pregnancy (high blood pressure, hemorrhage, syphilis); risk behavior during pregnancy (use of tobacco, alcohol, unlawful drugs); presence of the partner; and realization of prenatal care. Additionally, the maternal death was described by nationality, obstetric assistance provided, cause of death and outcome of the product of the pregnancy. Birth weight (BW, in grams) and gestation age (GA, in weeks) were described for the subgroups of the population of the study, except abortion, based on the indicators: proportion of extremely low BW (< 1,000g), very low BW (< 1,500g), low BW (< 2,500g) and early pre-term (< 32 weeks) and pre-term (< 37 weeks). The following records were excluded from the analysis of gestation age (GA) and birth weight (BW): records with inconsistency between the following information[24] - GA< 22 weeks and BW>600g; GA of 22-27 weeks and BW > 1,500g; GA de 37-41 weeks or GA ≥ 42 weeks and BW < 1,500g or > 5,500g. Frequencies of live births (LB) with 5-minute Apgar < 7 were described only for neonatal deaths and surviving births.

Fetal and neonatal deaths were classified by specific causes (three- and fourcharacter categories), groupings and chapters of the ICD[10]. Where there has been investigation of fetal and neonatal deaths, causes of death refer to those post-investigations recorded in the SIM. Additionally, the investigators, not knowing such information, filled in a new death certificate (in São Paulo, by the general coordinator of the survey, and in Rio de Janeiro State, by the third author of the article), codified the causes of death and selected the underlying cause (fourth author of the article).

The analyses of causes of death were carried out separately for the fetal deaths and the neonatal deaths, and by a certifying source (SIM, and research). The underlying cause of death (CD) was classified by chapter and grouping of the ICD and by specific causes (three- and four-character categories) only for the principal groupings. The changes in the frequency of deaths by chapter and grouping informed by the SIM and certified by the survey by moment of death (fetal/neonatal) were calculated: positive values expressed increases and negative values reduction. The frequency of diagnoses other than the underlying CD was described as accounted, independently of its location in the Death Certificate (same line, or not, of Part I or in Part II), and the reliability of the underlying CD informed by the SIM and certified by researchers was analyzed.

Statistical analyses

The following indicators for hospital death were calculated: maternal death ratio per 100,000 LB, risk of fetal death, fetal deaths per 1,000 births, and risk of neonatal death per 1,000 LB[10].

The absolute and percentage distributions of the concepti according to socio-economic and demographic characteristics, and reproductive, pregnancy and birth history, were described. To test the hypothesis of homogeneity of proportion

a Pearson chi-squared test or a Fisher's exact test were carried out. For ordinal categorical variables, the chi-squared test for linear trend was used.

The frequency distribution and position of the underlying CD by ICD chapter and grouping and by specific cause (three- and four-character) were described only for the principal groupings. The mean, and the absolute frequency, of diagnoses other than the declared underlying CD (SIM and research) were calculated. The McNemar test was carried out to investigate difference between the proportions of death by cause, by ICD chapter and grouping informed by the SIM, and those informed by the researchers. For evaluation of the reliability of the underlying CD (dichotomous variables for the specific cause – yes/no – informed by the SIM and by the research) the percentage agreement was calculated (< 25% - bad; de 25% to 49% - regular; 50% to 74% - good and ≥ 75% - very good)[25] and the kappa coefficient (< 0.00 – poor; 0.00-0.20 – superficial; 0.21-0.40 – reasonable; 0.41-0.60 – moderate; 0.61-0.80 – substantial; 0.81-1.00 – almost perfect)[26].

Ethical considerations

This study was approved by the Research Ethics Committee of the Collective Health Studies Institute of the Federal University of Rio de Janeiro, the Rio de Janeiro Municipal Health and Civil Defense Department, the Study Centers of each Maternity Unit of Rio de Janeiro State, and the research Ethics Committee of the Public Health Faculty of São Paulo University, and participating hospitals of São Paulo. Informed consent was requested from all the eligible pregnant women, or for those under age 18, their guardians.

Results

The hospital maternal mortality ratio was 13.6 per 100,000 LB and the risk of fetal death was 8.8 per 1,000 births (13.9 per 1,000 in the RJ centers, and 7.1 per 1,000 in the SP centers). The neonatal mortality ratio was 6.0 per 1,000 LB (10.1‰ in RJ centers, 4.7‰ in SP centers).

Study population

The only maternal death was of a woman resident in the municipality of São Paulo, born in Bolivia, age 34, color described as 'yellow' and with low level of schooling. She did not live with a partner, her profession was stated as *homemaker*, she had had five previous pregnancies (one abortion and four live births) and the present pregnancy resulted in fetal death (560 grams and 23 weeks). She had had no prenatal care and reported no morbidity or risk behavior during the pregnancy. The death took place in the puerperium immediately after transfer to a hospital of greater complexity. The underlying cause of the death was *other hemorrhages immediately postpartum* (ICD code O72) and the associated cause recorded was *pulmonary tuberculosis* (ICD code A162).

Of the 7,898 concepti, there were 498 abortions. Of these, 29.1% were without expulsion of the embryo; 64.5% spontaneous; 0.4% induced, specified by law or by court of law; 3.2% induced; and 2.8%, unknown. The method most used to directly cause abortion was use of the drug Misoprostol. The proportion of induced abortions in the RJ center (11.9%) was approximately 12 times the proportion for the SP center (1%), while for spontaneous abortion it was 30% higher in the SP center (68.1%) than in the RJ center (50.5%). Of the births, 65% were fetal deaths, and 7,335 live births were followed by 44 hospital neonatal deaths.

Table 1 shows the distribution of the concepti by characteristics of social-demographic, reproductive and pregnancy history, risk behavior, healthcare, and characteristics of newborns.

Concepti were heterogeneous in all the maternal socio-demographic characteristics (p value < 0.05). In the outer ends of the age ranges, 34% of the fetal deaths were to adolescent mothers, and 20% of the abortions were in women over 35. Women with black skin color were a higher proportion among fetal and neonatal deaths than among mothers of survivors (13.5%), reaching 30.2% of neonatal deaths. There was a higher percentage of mothers with low schooling among the fetal deaths (32.3%). There was a predominance of women with a partner among the neonatal deaths and survivors, and absence of partner among abortions and fetal deaths.

Except for previous stillbirths, all the other reproductive characteristics differed by the type of outcome (p value < 0.0001). Among mothers that had abortions, 11.1% had a history of four or more births. Prior abortion was reported more frequently among the subgroups of death than the subgroup of survival.

Maternal high blood pressure and syphilis were more frequent except among the abortions,

Table 1. Study population – pregnancy outcomes and characteristics of mother and conceptus, Rio de Janeiro, Niterói (RJ center) and São Paulo (SP center), Brazil, 2011.

Characteristics	Abortion		Fetal deaths [a]		Neonatal death		Surviving infants		p-value
	n = 498	%	n = 65	%	n = 44	%	n = 7291	%	
Maternal socio-demographic characteristics									
Birth or abortion center									<0.0001
São Paulo	397	79.7	40	61.5	26	59.1	5531	75.9	
Rio de Janeiro	101	20.3	25	38.5	18	40.9	1760	24.1	
Age group									<0.0001
10-19	75	15.1	22	33.8	8	18.2	1618	22.2	
20-34	322	64.7	34	52.3	33	75.0	5022	68.9	
35 and over	101	20.3	9	13.8	3	6.8	651	8.9	
Skin color									0.001
'White'	197	40.9	19	30.2	17	39.5	2630	36.9	
'Brown'	188	39.0	33	52.4	12	27.9	3354	47.1	
'Black'	86	17.8	10	15.9	13	30.2	959	13.5	
Other	11	2.3	1	1.6	1	2.3	182	2.6	
Level of education									0.047
<8 years	85	17.5	20	32.3	7	16.7	1393	19.7	
> = 8 years	402	82.5	42	67.7	35	83.3	5690	80.3	
Partner present	168	34.1	15	23.4	29	65.9	4709	65.3	<0.0001
Reproductive history									
Number of previous births [b]									0.01
None	126	31.9	24	36.9	18	40.9	3062	42.0	
1-3	225	57.0	36	55.4	22	50.0	3720	51.1	
4 and over	44	11.1	5	7.7	4	9.1	501	6.9	
Prior stillbirths [d]	10	2.0	2	3.2	-	-	120	1.7	-
Prior abortions	124	25.0	12	19.0	10	22.7	1303	17.9	0.01
About the pregnancy									
Self-Reported arterial hypertension	17	3.4	12	18.5	6	13.6	853	11.7	<0.0001
Self-Reported hemorrhage [d]	90	18.1	5	7.7	6	13.6	402	5.5	-
Reported syphilis [d]	3	0.6	6	9.2	3	6.8	140	1.9	-
Used tobacco	85	17.3	8	12.5	9	20.5	1062	14.6	0.252
Used alcohol	73	14.8	10	15.6	13	30.2	972	13.4	0.01
Used illicit drugs [d]	11	2.2	-	-	3	7.0	96	1.3	-
Suffered violence [d]	24	4.9	6	9.7	-	-	283	3.9	-
No prenatal care [d]	315	63.3	6	9.2	7	16.3	110	1.5	-
Newborns									
Weight at birth <1000g [d]	NA	NA	20	34.5	21	53.8	6	0.1	-
Weight at birth <1500g [d]	NA	NA	33	56.9	28	71.8	38	0.7	-
Weight at birth <2500g	NA	NA	45	77.6	32	82.1	463	8.0	<0.0001
Gestation age <32 weeks d weeks	NA	NA	33	56.9	27	69.2	127	2.2	-
Gestation age <37 weeks	NA	NA	46	79.3	30	76.9	657	11.4	<0.0001
5-min Apgar <7 [c]	NA	NA	NA	NA	21	47.7	6	0.1	<0.0001

NA = not applicable; g = grams; weeks = weeks of pregnancy. a (≥22 weeks); b Chi-Squared linear trend; c Fisher test; d Not possible to test statistical significance due to low frequencies. Note: Records with information not known have been excluded from the analysis. Additionally, the following were excluded from analysis of birth weight and gestational age: Inconsistencies between the two variables resulting in 58 stillbirths; 39 neonatal deaths; 5,775 surviving infants.

when hemorrhage prevailed. Use of tobacco, alcohol and drugs were more common among the mothers with neonatal deaths. In this group, no mother stated that she had suffered violence during pregnancy. Among the morbidities and risk behaviors, only high blood pressure and use

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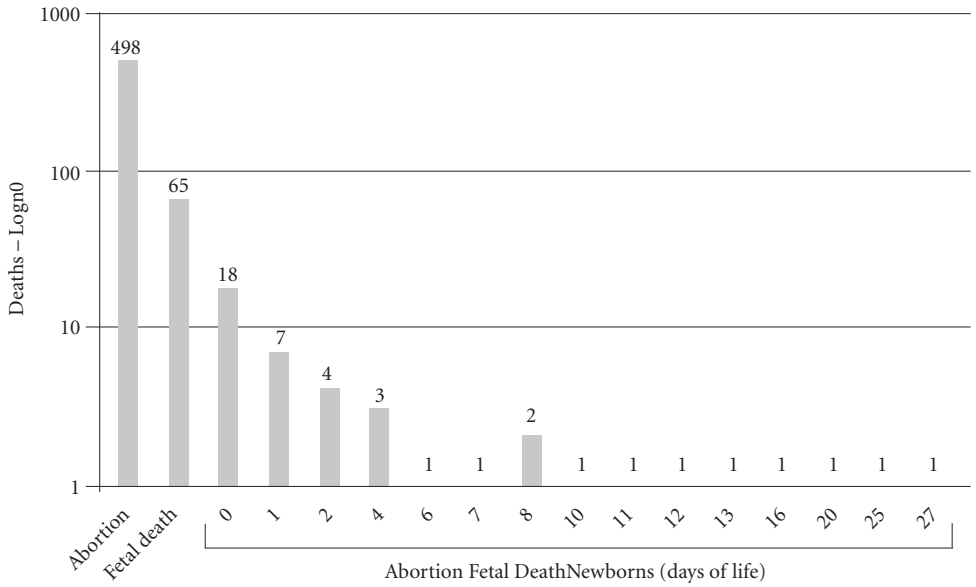

Graph 1. Distribution of fetal losses* and neonatal deaths by time of death in public maternity facilities in the cities of Rio de Janeiro, Niterói and São Paulo, Brazil, 2011.

* Fetal losses: Abortion and fetal death (< 22 and ≥ 22 weeks gestation age, respectively).

of alcohol were statistically significant ($p < 0.05$). Not having prenatal care was most frequent among the cases of abortion (63%). Low birth weight and premature birth were more frequent among fetal and neonatal deaths ($p < 0.0001$).

As to the moment of occurrence of fetal and neonatal death, reduction in frequency was observed as pregnancy age and chronological age increased (Graph 1). There was relative decline (approximately 87%) in the number of deaths, from highest at the start of pregnancy (498 abortions), to 65 fetal deaths at the twenty-second week of pregnancy, and by 72% from this point to the first day of incomplete life (18 neonatal deaths).

Causes of deaths of the conceptus

The investigation of deaths reported by SIM occurred in 83.1% of the fetal deaths and 84.1% of the neonatal deaths. The principal underlying causes of deaths by ICD chapter were *perinatal causes* (XVI) followed by *congenital malformations* (XVII) and *infectious and parasitic diseases* (I), both among those informed by the SIM and those certified by the researchers. A neonatal death was certified by the researchers as *external causes* (XX). For the fetal deaths, in the certification by the researchers, as compared to the information from the SIM, the frequency of infectious and parasitic diseases and congenital malformations was higher; and the frequency of perinatal causes was lower; for the neonatal deaths, the frequency of congenital malformations was lower and the frequency of other causes was higher.

Table 2 shows the distribution of fetal and neonatal deaths by underlying CD and number of diagnoses, and also underlying CD by ICD grouping, informed by the SIM and certified by the researchers.

Among fetal deaths, 78% of the underlying CDs informed by SIM were due to *respiratory and cardiovascular disorders specific to the perinatal period* (P20-P29), exclusively due to *intrauterine hypoxia, unspecified* (P20.9), and *newborn affected by maternal factors and by complications of pregnancy, labor, and delivery* (P00-P004), highlighting, in this group, *newborn affected by maternal hypertensive disorders* (P000) and *other forms of placental separation and hemorrhage* (P021).

Table 2. Groupings of underlying cause of death (UCD) of stillbirths and neonatal deaths; number of diagnoses other than the UCD, as informed by the Mortality Information System (SIM) and by the researchers; and proportion of change from the CD informed by SIM and certified by the researcher; in maternity facilities in the cities of São Paulo, Rio de Janeiro and Niterói, Brazil, 2011.

Basic cause of death (CD) by ICD grouping (10th Revision)	Yes							Researchers							Change
	n0	%	n0 diagnoses other than UCD					n0	%	n0diagnoses other than UCD					UCD %
			0	1	2	3	≥4			0	1	2	3	≥4	
Fetal deaths [a]															
A50-A54: Infections with a predominantly sexual mode of transmission	2	3.1	-	1	-	1	-	5	7.7	4	1	-	-	-	150.0
P00-P04: Newborn affected by maternal factors and by complications of pregnancy, labor, and delivery	20	31.3	1	14	4	1	-	21	32.3	4	9	5	3	-	5.0
P05-P08: Disorders of newborn related to length of gestation and fetal growth	-	-	-	-	-	-	-	1	1.5	1	-	-	-	-	-
P20-P29: Respiratory and cardiovascular disorders specific to the perinatal period	30	46.9	29	1	-	-	-	4	6.2	2	2	-	-	-	-86.7c
P35-P39:Infections specific to the perinatal	1	1,6	-	1	-	-	-	-	-	-	-	-	-	-	-
P70-P74:Transitory endocrine and metabolic disorders specific to newborn	1	1.6	-	-	1	-	-	5	7.7	2	1	1	0	-	300.0
P90-P97:Other disorders originating in the perinatal period	7	10.9	6	1	-	-	-	24	36.9	24	0	0	0	-	242.9c
Q00-Q07:Congenital malformations of the nervous system	1	1.6	1	-	-	-	-	1	1.5	1	0	0	0	-	0.0
Q20-Q28:Congenital malformations of the circulatory system	-	-	-	-	-	-	-	1	1.5	0	0	1	0	-	-
Q80-Q89:Other congenital malformations	1	1.6	-	1	-	-	-	3	4.6	2	0	1	0	-	200.0
Q90-Q99:Chromosomal abnormalities, not elsewhere classified	1	1.6	-	0	1	-	-	-	-	-	-	-	-	-	-
Total	**64**	**100**	**37**	**19**	**6**	**2**	**-**	**65**	**100**	**40**	**13**	**8**	**3**	**-**	**-**

it continues

After certification by the researchers, a different group was more dominant: *other disorders originating in the perinatal period* (P90-P97), exclusively due to *fetal deaths from unspecified causes* (P95), corresponding to undefined causes for stillbirths (Table 2). The number of diagnoses, as well as the underlying CD, in death certificates of the fetal deaths varied between zero and three; in approximately 60% (SIM) and 62.5% (researchers) there was a record only of the underlying CD, principally when classified in the group *respiratory and cardiovascular disorders* (SIM) and *other disorders originated in the perinatal period* (researchers) (Table 2). The average of diagnoses other than the underlying CD certified by the researchers was 1.9, and for the SIM, 1.3.

More than half of the causes of neonatal deaths at the level of grouping were also due to *specific respiratory and cardiovascular disorders of the perinatal period* (P20-P29) and *maternal*

Table 2. continuaçtion

Basic cause of death (CD) by ICD grouping (10th Revision)	Yes							Researchers							Change
	n0	%	n0 diagnoses other than UCD					n0	%	n0diagnoses other than UCD					UCD %
			0	1	2	3	≥ 4			0	1	2	3	≥ 4	
Neonatal deaths															
A50-A54: Infections with a predominantly sexual mode of transmission	-	-	-	-	-	-	-	1	2.3	1	-	-	-	-	-
P00-P04: Newborn affected by maternal factors and by complications of pregnancy, labor, and delivery	11	25	-	-	2	4	5	17	38.6	-	6	9	1	1	54.5
P05-P08: Disorders of newborn related to length of gestation and fetal growth	3	6.8	-	1	2	-	-	6	13.6	6	-	-	-	-	100.0
P10-P15: Birth trauma	-	-	-	-	-	-	-	1	2.3	-	-	1	-	-	-
P20-P29: Respiratory and cardiovascular disorders specific to the perinatal period	13	29.5	-	1	5	5	2	8	18.2	1	2	3	1	1	-38.5
P35-P39: Infections specific to the perinatal period	6	13.6	-	1	-	1	4	1	2.3	-	1	-	-	-	-83.3
P75-P78: Digestive system disorders of fetus and newborn	-	-	-	-	-	-	-	1	2.3	-	1	-	-	-	-
P90-P97: Other disorders originating in the perinatal period	1	2.3	-	-	-	-	1	-	-	-	-	-	-	-	-
P90-P97: Congenital malformations of the nervous system	5	11.4	-	2	2	1	-	5	11.4	2	1	1	1	-	0.0
Q20-Q28:Congenital malformations of the circulatory system	1	2.3	-	-	1	-	-	1	2.3	1	-	-	-	-	0.0
Q30-Q34: Congenital malformation of the nose	2	4.5	-	-	1	0	1	1	2.3	-	-	-	1	-	-50.0
Q60-Q64: Congenital malformations of the urinary system	1	2.3	-	1	-	-	-	1	2.3	-	-	-	1	-	0.0
Q65-Q79: Congenital malformations and deformations of the musculoskeletal system	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-
W00-W19: Slipping, tripping, stumbling and falls	-	-	-	-	-	-	-	1	2.3	-	1	-	-	-	-
Total	**44**	**100**	**-**	**6**	**13**	**11**	**14**	**44**	**100**	**11**	**12**	**14**	**5**	**2**	

[a] Fetal death (≥ 22 weeks pregnancy); [b] One abortion was corrected to stillbirth (it was not registered in the Mortality Information System); [c] McNemar test ($p < 0.001$)
Sources: Mortality Information System (São Paulo - PRO-AIM; Rio de Janeiro - State Health Department).

factors and complications of pregnancy, labor, and delivery (P00-P004) when informed in the SIM (54.5%), and 56.8% when certified by the researchers, with only the first and second positions of greatest frequency alternating. Among the neonatal deaths informed by the SIM, all showed at least one diagnosis other than the underlying CD, and in five records this number exceeded four. In the research, 11 neonatal deaths presented only the underlying CD in the death certificate, and the maximum number of diagnoses other than the CD was four. The main groupings, P20-P29 among the neonatal deaths informed by the SIM, and P00-P004 certified by

the researchers, presented a larger number of diagnoses other than the underlying CD (Table 2). The average number of diagnoses other than the underlying CD of the neonatal deaths were greater than that for the stillbirths, and the number for the researchers (3.0) was also greater than the number from the SIM (2.7).

Changes in the basic cause of death of concepti

The principal change of specific underlying CD of the fetal deaths was from *unspecified intrauterine hypoxia* (P209), informed by the SIM (30), to *fetal deaths for unspecified causes* (P95), certified by the researchers (16). In all the situations in which this change occurred there was no diagnosis other than the basic cause (SIM and researchers). For eight fetal deaths of which the underlying CD informed by the SIM was P209, there was a diagnosis other than underlying CD, six in the grouping *maternal factors and complications* (P00-P04) and two *transitory and specific endocrine and metabolic disorders* (P70-74), which became the underlying CD adopted by the researchers. For a fetal death, the underlying CD *unspecified intrauterine hypoxia* in the SIM changed to *early congenital syphilis, symptomatic* (A500) by the researchers. *Intrauterine hypoxia* was not maintained as underlying cause for any of the fetal deaths after certification by the researchers.

The specific changes of causes of neonatal deaths between the SIM and the researchers were more distributed between the ICD codes. However, two changes of underlying CD of neonatal deaths reported in the SIM and certified in the research attracted attention. In one death, *unspecific bacterial septicemia* (P369) was informed by the SIM and *early congenital syphilis, symptomatic* (A500) was certified by the researchers. The second change was from the natural cause *preterm newborn (other)* (P073) informed by the SIM to the unnatural cause, *other slipping, tripping and stumbling and falls* (W18), certified by the researchers.

Statistically significant changes of underlying CD informed by the SIM and by the researchers occurred only by grouping (P20-P29 and P90-P97) for the fetal deaths ($p < 0.01$) (Table 2).

Reliability of the basic cause of death of the concepti

The reliability of the neonatal CDs was higher than that of the fetal deaths, it being found that, since the causes of death are more specified, the agreement between the SIM and the researchers diminishes (Table 3). The percentage agreement per chapter of the ICD was very good both for stillborns and for neonatal deaths; the kappa coefficient presented a substantial agreement (0.70) and moderate agreement (0.54) for the neonatal and stillborn deaths, respectively. The neonatal deaths showed moderate agreement (kappa = 0.40) and reasonable agreement at the three-character level (kappa = 0.23) and four-character level (kappa = 0.5). For the fetal deaths, the agreement by grouping and specific cause was superficial (Table 3).

Table 3. Percentage agreement between causes of fetal and neonatal death informed by the Mortality Information System, and certified by this study, in public maternity facilities of the cities of Rio de Janeiro, Niterói and São Paulo, 2011.

	Fetal deaths[a] (n = 64)				Neonatal deaths (n = 44)			
	Agreement %	Kappa coefficient[b]	CI 95%		Agreement %	Kappa coefficient[b]	CI 95%	
Chapter	90.63	0.54	0.34	0.78	88.64	0.70	-	-
Grouping	31.25	0.16	0.06	0.26	51.16	0.40	0.24	0.62
Three-character categories	26.56	0.17	0.13	0.21	27.27	0.23	0.10	0.27
Four-character categories	20.31	0.14	0.12	0.21	27.7	0.25	0.18	0.29

CI 95: Confidence interval 95% for the kappa coefficient. a Fetal deaths correspond to fetal deaths in the perinatal component (pregnancy age ≥22 weeks). b p-value < 0.001.
Sources: Mortality Information System (São Paulo - PRO-AIM; Rio de Janeiro - State Health Department).

Discussion

This study made it possible to evaluate the whole spectrum of deaths dependent on the occurrence of pregnancy.

There was one maternal death, for 7,335 live births in this study. In absolute numbers, maternal death is a rare event, and possibly the occurrence in the SP center was due more to the frequency of live births (75.8%) than to the demand of risk pregnancy and/or worse obstetric care. In the multi-centric cross-sectional study in 2010/11, in seven participating Brazilian maternity wards, there was one maternal death and the ratio of maternal death was 14.2/100,000 LB[21], a similar value to that of this study.

The worst scenario for fetal and neonatal death was in the RJ center. Except for one maternity ward in São Paulo, the others are reference facilities for risk pregnancies. It would be taken into account that as well as the positive differences in quality of obstetric and neonatal care between the RJ and SP centers, in the maternity facility of the city of Niterói, which is reference for the II Metropolitan Region of Rio de Janeiro State, a large portion of the mothers admitted are at-risk pregnancies, and come from the most improvised municipalities, increasing the risks of death of women and concepti. The risk of fetal death estimated for this study gave priority to birth weight following the definition of the ICD[10] and, thus, may be underestimated[27]. This underestimation may be greater when the frequency of births with restriction of intrauterine growth is high[27].

The socio-demographic characteristics of mothers who died in this study, as well as the associated cause of death (pulmonary tuberculosis), express conditions of vulnerability[2]. The certified causes of death, hemorrhage and obstruction of the birth, are the most frequent complications at the moment of birth and are common to maternal, neonatal and fetal death[22]. This tragedy resulted in two deaths, the mother and the conceptus, and four orphans. Only improvements in professional and institution care at birth, independently of women's conditions, are capable of significantly reducing the occurrence of maternal deaths[3].

As pointed out in other studies[8,9,20], errors of classification of the type of abortion, due to illegality, result in underestimation of induced abortions, which has compromised knowledge about this type of abortion. In the RJ center, the proportion of induced abortions was greater than in SP, a result that is compatible with the national survey[20]. In this study, among the induced abortions, the use of Misoprostol was recorded by almost all the respondents, in spite of this drug being restricted to qualifying hospitals. Illegal selling of Misoprostol favors its adulteration and the risk of sale of presentations with sub-doses or without the active principle compromises its efficacy[28], exposing women to risk situations, either due to the access to the medication or to success not being achieved[29]. Abortion is an important cause of maternal morbimortality, principally when carried out in unsafe conditions[30].

Abortion, fetal death, neonatal death and infant survivors were distinct groups, corroborating results of studies on risk factors and mortality[11-13,15,20], except for some peculiarities. Concepti show themselves to be homogeneous in relation to the variables *prior stillbirths* and *use of tobacco* (p value > 0.20). Prior stillbirth was described as an independent risk factor for fetal deaths[15] and neonatal deaths[13] and, not only use of tobacco, but also use of alcohol and drugs, were not associated with fetal deaths[15]. The low gestation age of the abortions could have influenced the access to pre-natal care.

Certain socio-demographic characteristics stood out for their high frequency: examples are adolescence, among fetal deaths; black maternal skin color among fetal and neonatal deaths[13] and absence of partner in the cases of abortion or fetal death[15]. These characteristics suggest the influence of social inequality in care and in health outcomes[2].

Among the perinatal deaths, fetal deaths predominated (66.3%); neonatal deaths occurred primarily in the first 48 hours, in line with the literature[1,6,13].

In spite of it being obligatory[31], more than half of the fetal and neonatal deaths had not been investigated. Investigation of a death makes it possible to qualify the certification of the causes of death. In 2011 investigation was not universal and the health departments established criteria of priority[32,33]. Similarly, it is expected the certification of causes of death by the researchers should be more qualified than the original certification in the majority of cases. The differences between the certifications by the SIM and the researchers resulted in ordering of the CDs and in the agreement, fundamentally on ICD grouping. However, the underestimation of congenital syphilis (Chapter I) among stillbirths and neonatal deaths, and slips, tumbles, etc. (Chapter XX) in neonatal deaths according to the SIM contrib-

uted to weakening the agreement also in terms of chapter.

Disagreements on CD informed by the SIM and by the researchers were greater among fetal deaths than among neonatal deaths, and increased with the specificity of cause (by four-character chapter). This shows on one side the lack of qualification of the professionals in recognizing the causal chain that resulted in death[18]; and on the other hand, the presence of a complex interrelationship between the various causes[18]. Brazilian studies have shown low reliability of CD for fetal, perinatal and infant deaths[15,17,18,34,35].

Among the fetal deaths, the principal change of basic cause between the SIM and the research was from *unspecified intrauterine hypoxia* to *unspecified cause of fetal death.* This change has also been highlighted in similar studies of fetal[15] and perinatal[35] deaths, and may reflect the incompleteness of the medical record for the fetal death, or non-realization of postmortem or lack of information in the diagnoses[17,35]. The absence of clinical information about the pregnancy and the birth and non-inclusion of the placentas in the postmortem were obstacles to precision in the causes of death[17].

Intrauterine hypoxia is the terminal stage of the causal chain of death, and thus should not be certified as the cause of death: *unspecified causes of fetal death* are the 'unclear causes' of the perinatal deaths. Both the diagnoses (P209 and P95) are non-specific in terms of leading to prevention measures[36].

In spite of the small absolute number of fetal deaths, the frequencies of congenital syphilis (A50-A54) and diabetes (P70-P74) were, respectively, 2.5 and 5 times greater when compared to the information of the SIM. These causes of fetal death arise from maternal morbidities that are considered to be modifiable by better obstetric assistance and are frequent in countries of average and low income[11]. In Brazil, the prevalence of syphilis in pregnancy is greater in the absence of prenatal care, and even when this is carried out, the late start can be a barrier to diagnosis and treatment at the recommended fetal age[37]. The population fractions attributable to syphilis and pre-pregnancy diabetes in fetal death worldwide have been estimated at approximately 8% and 7%, respectively[11]. Congenital syphilis has also been under-registered as a basic cause of neonatal deaths, as shown in a study in the Brazilian state of Alagoas in the previous decade[18]. The authors highlight the avoidability of neonatal deaths due to congenital syphilis and diabetes in pregnancy, among other causes.

The qualification of the CD of the fetal and neonatal deaths by the researchers can be evaluated also from the increase in the number of certified diagnoses. Sometimes the doctors omit to inform diagnoses, and also the CD, in the death certificate, because they are already recorded in the medical record[38]. Other factors, particularly for fetal deaths, are issues relating to ICD codes, scarce and incomplete information for the conditions of the placenta, and the model of the death certificate itself, which does not include information on complications in pregnancy and birth[27].

A limitation of the survey was that (i) there is no Death Verification Service in the cities of Rio de Janeiro State, and (ii) in the city of São Paulo which does have the service, some results were imprecise for qualifying cause of death, as signaled by Almeida et al.[17] Additionally, the strategy of covering a larger sample of newborns by choosing maternity facilities with higher numbers of births in the SUS in the cities investigated by the survey, similar to the sampling strategy used in the World Health Organization's multicentric Maternal and Newborn Health survey[39], meant that the sample was not random.

As positive points of the study it can be pointed out that there is practically no error of classification for the fetal losses (abortion and fetal deaths), and for the fetal deaths with live births, the latter being already signaled in a publication with the database of the survey in the city of São Paulo[40].

To achieve better filling out of the death certificate, and consequent precision on causes of death, there is a need for the attention of doctors and principally the medical students to be drawn to the individual definitions of the deaths involved (maternal, abortion, fetal component of the perinatal death, and infant death, in their various components) and the inclusion of all illnesses in the death certificates[38], those of the newborn and those consequent upon maternal morbidities. This would have a beneficial effect on the quality of care.

Good-quality care in reproductive planning, pre-natal care, and care during the birth will result in prevention of abortions, fetal deaths, maternal deaths and neonatal deaths[11].

Collaborations

PL Kale, MHPM Jorge, SC Fonseca, AM Cascão, KS Silva, AC Reis and MT Taniguchi are responsible for the content of the article and agree with the version sent for publication.

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