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ORIGINAL RESEARCH

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APPLICATION OF THE INTERNATIONAL CLASSIFICATION OF DISEASES FOR PERINATAL MORTALITY (ICD-PM) TO VITAL STATISTICS RECORDS FOR THE PURPOSE OF CLASSIFYING PERINATAL DEATHS IN ANTIOQUIA, COLOMBIA

Aplicación del sistema de Clasificación Internacional de Enfermedades para la Mortalidad Perinatal CIE-MP a partir de registros vitales para clasificar las muertes perinatales en Antioquia, Colombia

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ABSTRACT

Objective: To describe perinatal mortality in the Department of Antioquia based on the WHO International Classification of Diseases (ICD-PM) and determine the feasibility of applying this classification system to government records of vital statistics.

Materials and methods: Descriptive study of the causes of perinatal death according to the time of death in relation to the time of delivery and associated maternal conditions. The primary source was the official vital records database for the period between 2013 and 2016. The variables measured were maternal age, gestational age and weight at the time of birth, area of residence, type of delivery, and causes of death, including direct and associated causes, and other pathological conditions. A descriptive analysis is performed, causes are presented in terms of absolute numbers and percentages and distributed according to the time of death in relation to childbirth and birthweight.

Results: Of 3901 perinatal deaths occurring in fetuses 22 weeks or more of gestational age or a minimum weight of 500 g, and up to 28 days of life, 1404 (36.0%) occurred before delivery, 378 (9.7%) during the intrapartum period, 1760 (45.1%) during the neonatal period, and 359 (9.2%) cases had no information regarding the time of death in relation to the time of delivery. The main causes of death of neonates weighing 1000 g or more were congenital malformations, deformities and chromosomal abnormalities (30.2%), antepartum and intrapartum hypoxia (29.3%), and infection (12.3%). In 69.5% of cases, no associated maternal causes were identified and in those in which they

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were identified, the most frequent was complications of placenta, cord and membranes (16.8%).
Conclusion: The ICD-PM is a system applicable globally to records of vital statistics, which enabled characterization of perinatal mortality in the Department.
Key words: Perinatal mortality, fetal mortality; infant mortality; vital statistics; International Classification of Diseases.

RESUMEN

Objetivo: describir la mortalidad perinatal del departamento de Antioquia según la Clasificación Internacional de Enfermedades CIE-MP de la Organización Mundial de la Salud (OMS) y evaluar la factibilidad de aplicar el sistema de clasificación a partir los registros vitales oficiales.
Materiales y métodos: estudio descriptivo de las causas de muerte perinatal según el momento del fallecimiento con respecto al parto y las condiciones maternas asociadas. La fuente primaria fue la base de datos oficial de estadísticas vitales entre los años 2013 y 2016. Se midieron: la edad materna, la edad gestacional, el peso al momento del parto, el área de residencia, el tipo de parto, las causas de muerte (directas, asociadas) y otros estados patológicos. Se hace análisis descriptivo, se presenta el número absoluto y el porcentaje de las causas distribuidas según el momento de ocurrencia de la muerte con respecto al parto y el peso al nacer.
Resultados: de 3901 muertes perinatales ocurridas en fetos con 22 semanas o más, o mínimo 500 g de peso y hasta los 28 días de vida, 1404 (36,0 %) se presentaron antes del parto, 378 (9,7 %) en el intraparto, 1760 (45,1 %) en el periodo neonatal y 359 (9,2 %) casos no contaban con información del momento del fallecimiento con relación al parto. Las principales causas de muerte de los recién nacidos de 1000 o más g fueron las malformaciones congénitas, las deformidades y las anormalidades cromosómicas (30,2 %); la hipoxia anteparto e intraparto (29,3 %) y la infección (12,3 %). En el 69,5 % no se identificaron causas maternas asociadas, y en las identificadas, la más frecuente fue la complicación de placenta, cordón y membranas (16,8 %).
Conclusión: el CIE-MP es un sistema de clasificación aplicable globalmente a partir de los registros vitales, que permitió caracterizar la mortalidad perinatal del departamento.
Palabras clave: mortalidad perinatal; mortalidad fetal; mortalidad infantil; estadísticas vitales; Clasificación Internacional de Enfermedades.

INTRODUCTION

After remaining invisible for a long time, perinatal mortality in general, and its components of stillbirths and neonatal mortality, have begun to find a relevant place in the public agenda worldwide over the past few years (1, 2). Currently, neonatal mortality rates are an important health measurement of the world's population because a large proportion of deaths (45% in 2015) of children under five years of age occur in the first months of life, and because stillbirth rates have received more attention given the recognition that a significant proportion of deaths occurring after 28 weeks of gestation (3) in a large number of viable fetuses are preventable. One of the Sustainable Development Goals (SDGs) is to put an end to preventable neonatal deaths and reduce neonatal mortality by at least 12 deaths in 1000 live births by the year 2030 (4). At the same time, the strategy "Every newborn: an action plan to end preventable deaths," supported by the World Health Organization (WHO), set the goal of 10 or less stillbirths for every 1000 live births in all countries by the year 2035 (5).

The first step to conduct a program on perinatal mortality is the collection and accurate and consistent classification of the causes and conditions associated with those deaths (6). Despite the progress made, deficiencies have been described in the way perinatal mortality, in particular stillbirths, are captured and categorized under the existing classifications (7). Based on the Tenth Revision of the International Classification of Diseases (ICD 10),

the WHO developed a system adapted to perinatal death (International Statistical Classification of Diseases and Related Health Problems – Perinatal Mortality ICD-PM) in an attempt at improving this landscape and overcoming existing challenges (8). This new system is expected to help with comparisons within and between various settings and with the identification of trends, gaps and modifiable factors in order to contribute to the prevention of future deaths (9). However, it has been documented that tradition is a key factor when it comes to the use of these types of classifications: a systematic review of 81 perinatal mortality classifications assessed showed that the majority are used almost exclusively by the developer group and only one-third have been used in more than one country or with more than 1000 cases (7).

The authors of a review of the various classification systems identified the WHO ICD-PM as the first universal classification system and highlighted the fact that, if its use becomes generalized, it has the potential of addressing the burden of perinatal mortality in the world. On the other hand, the authors contend that additional research is required in order to assess the system's performance and the different implementation approaches (6). Based on that need, the objective of this study was to assess the feasibility of applying the ICD-PM system using official vital statistics, and to describe the causes of perinatal mortality in the department of Antioquia.

MATERIALS AND METHODS

Design and population. Descriptive, cross-sectional study of all perinatal deaths that occurred in Antioquia, a department in northeastern Colombia, between 2013 and 2016. During the study period, the average number of live births per year was 75,533, perinatal mortality was 13.04 for every 1000 live births in 2013 and 13.11 in 2016; 99.3% of the births occurred in healthcare institutions with 90.8% attendance to four or more prenatal visits (10). Inclusion and exclusion criteria: death records of fetuses or neonates weighing 500 g or more and up to 28 days of life were included and, in the absence of fetal weight, deaths occurring after 22 completed weeks (154 days) of gestation (11). According to the ICD-10 instruction manual, when weight, gestational age and size are coded simultaneously in a death certificate, with no data, these cases are universally included in perinatal mortality statistics in order to avoid underregistration of the event (11); however, in this study, cases meeting clear criteria of early terminations were excluded because they had been given codes pertaining to miscarriages or related diagnoses (ICD-10 codes P018, P964, P95X, P00, P04, Q899), or because of the presence of words such as miscarriage, embryonic, anembryonic, ectopic, mole in cause descriptions.

Procedure. A database of the Antioquia Health Secretariat containing official vital statistics was obtained. The ICD-10 classification for perinatal deaths of the WHO ICD-PM (7) was used. The ICD-PM has three main characteristics: it identifies the time of perinatal death (antepartum, intrapartum, neonatal); it groups the causes of death logically, linked to the existing ICD codes; and it links maternal condition to perinatal death. The professionals who completed the death certificates identified the time of death in relation to childbirth under the same categories of the classification. According to days of life documented in the records, neonatal deaths were divided into early neonatal deaths occurring within the first 7 days of life (0-6 days) and late neonatal deaths, occurring after 7 days up until 28 days of life (8-28 days) (11). Some cases that were recorded as antepartum deaths but assigned ICD-10 codes indicating occurrence during labor (e.g., P038 "fetus and newborn affected by other specified complications of labor and delivery") were reassigned as intrapartum deaths.

Death certificates in Colombia include a direct cause of death, up to three antecedent causes and one associated pathologic condition, but these fields are not always filled logically by healthcare personnel. For this study, all the codes entered in each certificate were linked to an Excel worksheet

and used as the starting point to select those that would be used in the analysis, in accordance with rules defined before starting the research (already described or described below). When the diagnosis was not consistent with the coding rules of the Colombian National Statistics Department (DANE) or with the ICD-PM guidelines (7), leading to the detection of an illogical sequence in the chain of events, or when a non-plausible cause of death from the biological standpoint was detected, one of the diagnoses included in the ICD-PM which was consistent with the rest of the case information was selected among the associated diagnoses recorded in the certificate. A list of guidelines was also created in advance for the definition of the cause of death in those cases for which there were two equally possible causes; for example, for a case of antepartum death with intrauterine growth restriction and infection, infection was defined as having precedence. Premature neonates that also had an intrauterine growth restriction code were assigned to group N2. Neonates of less than 37 weeks of gestation where the only recorded cause of death was respiratory failure, or with no other documented potential cause of death, were assigned to group N9. This is acceptable for extreme prematurity, but possibly not so for premature neonates close to pulmonary maturation who may have had another condition which was not documented by the professionals who completed the death certificate. Although reassignment of cause or sequence may introduce information bias, it cannot be corrected with the primary source used for the research and it is a necessary procedure frequently used in reports based on these types of sources (12, 13).

The assignment of ICD-PM maternal and perinatal codes was done using predetermined Excel formulas. A list of maternal and perinatal mortality diagnosis codes consistent with ICD-10 and included in the ICD-PM was created. They were then linked by means of the "Search.V" function to the corresponding perinatal death groups according to the time of occurrence: antenatal deaths A1 to A6, intrapartum I1 to I7 and neonatal N1 to N11, and to the associated maternal cause M1 to M5 (7), as designated in Tables 1 and 3. The causes of death selected from each record were then linked to the list in order to place each case in one of the classification groups.

Measured variables: The selected variables were age in years, gestational age in weeks at the time of delivery plus birthweight in grams, area of residence, type of delivery, gender of the neonate, causes of death (direct, associated), and other pathologic conditions.

Statistical analysis. For population description, quantitative variables are presented as medians and 25th and 75th percentiles, and qualitative variables are described as absolute numbers and percentages, calculated on the basis of the total number of cases. The causes of death are presented as absolute numbers and percentages, discriminated according to the time of death, and tabulated in accordance with the match between the cause of perinatal death and the associated maternal cause, as recommended by the designers of the proposal. In order to allow comparisons with universally used figures, the causes of death are broken down between fetuses of less than 1000 g and, among those weighing 1000 g or more, up to 7 days of life (as recommended for international comparisons), and between 8 and 28 days of life. Data screening was performed on Microsoft Excel and the Statistical Package for the Social Sciences (SPSS) version 25.0 was used for data analysis.

Ethical considerations. This research was considered to be free of risk as it was based on the anonymous records collected as part of the government process of vital staistics. Consequently, it did not requiere informed consent (14). The use of the information was authorized by the Antioquia Health and Social Protection Secretariat.

RESULTS

At the time of the study period, the government database contained 5694 records of perinatal deaths.

After the screening process described above, 3901 records were found to meet the inclusion criteria and 1793 contained sufficient elements to determine that they corresponded to miscarriages, ectopic pregnancies or trophoblastic disease. Of these 3901 perinatal deaths, 1404 (36.0%) occurred before delivery, 378 (9.7%) during the intrapartum period, 1760 (45.1%) during the neonatal period and 359 (9.2%) cases lacked information about the time of death in relation to delivery and could not be assigned the ICD-PM classification.

There were 2157 cases with documented weight of 1000 g or more and available information on the time of death. They were mainly cases coming from the urban area with mean birthweight of 2200 g, and median gestational age of 35 weeks (Table 1). Four causes of perinatal mortality accounted for 71.7% of all deaths: 1) congenital malformations, deformations and chromosomal abnormalities (652 deaths in A1, I1 and N1, 30.2%); 2 and 3) antepartum and intrapartum hypoxia (in total, 631 cases in A3, I3 and N4, 29.3%); 4) infection (265 cases in A2, I4 and N6, 12.3%). Intrauterine hypoxia was most predominant during the antenatal period (59.1%), while hypoxia due to acute intrapartum events was more significant during delivery (57.9%), and congenital malformations, deformations and chromosomal abnormalities predominated during the early and late neonatal period (37.0 and 23.8%, respectively). No associated maternal causes were identified in 69.5% of cases: 41.6, 54.5, 87.4 and 92.6% of antenatal, intrapartum, early and late neonatal deaths, respectively. In those cases in which maternal conditions were associated with perinatal death, the most frequent were placenta, cord and membrane-related complications occurring in 16.8% (Table 2).

For the 1204 fetuses and neonates with documented weight under 1000 g, 42.3% of deaths occurred before birth, 15.8% during delivery, 31.1% during the early neonatal period, and 10.9% in the late neonatal period. The main causes of death in these fetuses and neonates were intrauterine and intrapartum hypoxia (17.9% and 8.9%, respectively), and in 59.5% there was no related maternal condition. Stratification according to the time of death showed that the main cause of death in the antepartum period was intrauterine hypoxia (42.2%); during the intrapartum period, the main cause was acute intrapartum event (55.3%); for deaths occurring during the early neonatal period, the main causes were respiratory and cardiovascular disorders (34%); and for the late neonatal period, other neonatal conditions (28%). In 59.5%, no maternal comorbidity was identified (Table 3).

Time of death was available for a total of 180 cases (4.6%) that could be assigned to a ICD-PM category. However, although a gestational age of 22 weeks or more was documented, weight at the time of death was unknown. Consequently, those cases were not reported in the Tables, given the decision to present the information broken down in accordance with that weight.

DISCUSSION

Congenital malformations, antepartum and intrapartum hypoxia, and infections, accounted for the highest proportion of perinatal deaths according to the time of occurrence. No associated maternal conditions were found in two-thirds of the cases, and the largest number of deaths occurred during the neonatal period.

This research confirmed the feasibility of implementing the ICD-PM classification system in a different region, and under different conditions, than those where the system was developed. A large number of deaths were classified using government vital statistic records as the primary source. It was possible to obtain information that enables simultaneous visualization of fetal/neonatal and maternal-related conditions using simple analyses and generating computerized routines in a widely used software. According to the designers of the proposed classification, comprehensive assessment

Table 1.
Sociodemographic and clinical characteristics of perinatal deaths of 1000 g or more, and up to 28 days of life. Antioquia, Colombia, 2013-2016

Characteristic	N=2157	%
Area of residence		
Town	1464	67.9
Populated center	147	6.8
Scattered rural	544	25.2
No information	2	0.1
Type of delivery		
Spontaneous	1355	62.8
Cesarean section	739	34.3
Instrumented	40	1.9
Unknown	23	1.1
Gender		
Male	1222	56.7
Female	906	42.0
Undetermined	29	1,3
Maternal age	**Mediana**	**25th-75th Percentiles**
Maternal age in years	24	11-49
Gestational age at delivery (weeks)	35	26-42
Birthweight (grams)	2200	1000-5000

of the maternal-perinatal care continuum is made possible by this simultaneity (7). Under these conditions, the methodology is considered generalizable and useful for epidemiological surveillance systems at the different levels of public health systems.

Given the potential benefits of a classification system for perinatal deaths designed to offer "an approach that is applicable on a global basis for capturing, reporting and understanding the causes of perinatal deaths in all settings" (15), the paucity of publications on its implementation is notorious, even after three years of its launch (8). In a review conducted in the Medline via PubMed, Embase and Web of Science databases using the terms "ICD Perinatal Mortality"; "ICD-PM," "International Classification of Disease and Perinatal," and "Mortality and Perinatal," only five articles with primary research on its application were retrieved. Two of them are part of the initial construction and validation of the system (16, 17), a third was carried out by members of the team entrusted with the initial validation to assess the compatibility of the new system with a previous one (18), two were carried out by independent groups with the aim of characterizing in-hospital mortality, one with 75 deaths in Zambia (19) and the other with 291 deaths in Sri Lanka (20).

In our study, the most frequent cause of antepartum mortality was hypoxia (59.1%), similar to the proportion found in South Africa and Sri Lanka

Table 2.
ICD-PM tabulation of perinatal cause of death and maternal morbidity broken down according to the time of death for fetuses or neonates weighing 1000 g or more and up to 28 days of life. Antioquia, Colombia, 2013-2016

Maternal condition	M1. Complications of placenta, cord and membranes	M2. Maternal complications of pregnancy	M3. Other complications of labor and delivery	M4. Maternal medical and surgical conditions	M5. No maternal condition	Total (%)
Antepartum deaths						
A1. Congenital malformations, deformations and chromosomal abnormalities	12	3	1	2	113	131 (17.1)
A2. Infection	6	4	0	11	5	26 (3.4)
A3. Acute antepartum event (hypoxia)	215	24	15	56	143	453 (59.1)
A4. Other specified antepartum disorder	12	2	2	13	24	53 (6.9)
A5. Disorders related to length of gestation and fetal growth	23	7	3	16	34	83 (10.8)
A6. Antepartum death of unspecified cause	8	5	0	7	0	20 (2.6)
Total (%)	**276 (36,0)**	**45 (5,9)**	**21 (2,7)**	**105 (13,7)**	**319 (41,6)**	**766**
Intrapartum deaths						
I1. Congenital malformations, deformations and chromosomal abnormalities	0	2	2	0	48	52 (29.2)
I2. Birth trauma	0	0	1	0	0	1 (0.6)
I3. Acute intrapartum event	27	12	17	5	42	103 (57.9)
I4. Infection	2	0	0	1	3	6 (3.4)
I5. Other specified intrapartum disorder	0	0	0	1	1	2 (1.1)
I6. Disorders related to fetal growth	3	1	4	1	3	12 (6.7)
I7. Intrapartum death of unspecified cause	0	0	2	0	0	2 (1.1)
Total	**32 (18.0)**	**15 (8.4)**	**26 (14.6)**	**8 (4.5)**	**97(54.5)**	**178**

Continuation Table 2

Maternal condition	M1. Complications of placenta, cord and membranes	M2. Maternal complications of pregnancy	M3. Other complications of labor and delivery	M4. Maternal medical and surgical conditions	M5. No maternal condition	Total (%)
Early neonatal deaths						
N1. Congenital malformations, deformations and chromosomal abnormalities	4	5	2	2	272	285 (37.0)
N2. Disorders related to fetal growth	0	0	0	0	3	3 (0.4)
N3. Birth trauma	0	0	0	0	1	1 (0.1)
N4. Complications of intrapartum events	17	4	5	4	31	61 (7.9)
N5. Seizures and disorders of cerebral status	2	0	0	0	13	15 (1.9)
N6. Infection	8	4	0	5	115	132 (17.1)
N7. Respiratory and cardiovascular disorders	4	4	5	3	159	175 (22.7)
N8. Other neonatal conditions	3	0	0	0	53	56 (7.3)
N9. Low birthweight and prematurity	6	2	2	5	13	28 (3.6)
N10. Other miscellaneous causes	0	0	0	0	1	1 (0.1)
N11. Neonatal death of unspecified cause	0	0	1	0	12	13 (1.7)
Total (%)	**44 (5.7)**	**19 (2.5)**	**15 (1.9)**	**19 (2.5)**	**673 (87.4)**	**770**
Late neonatal deaths						
N1. Congenital malformations, deformations and chromosomal abnormalities	0	1	0	1	181	183 (23.8)
N2. Disorders related to fetal growth	0	0	0	0	0	0
N3. Birth trauma	0	0	0	0	1	1 (0.1)
N4. Complications of intrapartum events	5	0	1	0	8	14 (1.8)
N5. Seizures and disorders of cerebral status	0	0	2	0	7	9 (1.2)

Continuation Table 2

Maternal condition	M1. Complications of placenta, cord and membranes	M2. Maternal complications of pregnancy	M3. Other complications of labor and delivery	M4. Maternal medical and surgical conditions	M5. No maternal condition	Total (%)
N6. Infection	3	2	1	4	91	101 (13.1)
N7. Respiratory and cardiovascular disorders	0	3	1	1	63	68 (8.8)
N8. Other neonatal conditions	1	0	2	1	45	49 (6.4)
N9. Low birthweight and prematurity	1	2	0	0	3	6 (0.8)
N10. Other miscellaneous causes	0	0	0	0	2	2 (0.3)
N11. Neonatal death of unspecified cause	0	0	0	1	9	10 (1.3)
Total (%)	**10 (2.3)**	**8 (1.8)**	**7 (1.6)**	**8 (1.8)**	**410 (92.6)**	**443**

(52.6 and 41.9%, respectively), but very different from the United Kingdom with no reported deaths due to that cause (16). The results of the Zambia study show a lower frequency of hypoxia (14.3%), but the sample size was 75 perinatal deaths. It may well be that many of the deaths attributed to unspecified cause in the United Kingdom (60.4%) and Zambia (71.4%) are assigned to antepartum hypoxia in our country, although confirmation tests are not available in most cases.

Acute intrapartum events obviously explain the majority of deaths occurring during labor and delivery in our study (57.9%), similar to the situation reported in South Africa (93.0%), the United Kingdom (64.8%) and Zambia (84%). With only 7 intrapartum deaths in Sri Lanka, the majority reported at this time were caused by malformations (71.4%). The figures of congenital malformations, deformations and chromosomal abnormalities as the most frequent cause of neonatal death in our study (37.0%) are higher than those reported in South Africa (4.8%), the United Kingdom (22.4%) and Zambia (2.3%), and slightly lower than in Sri Lanka (44.2%). Explaining these differences is not possible on the basis of the available information.

The absence of an identifiable maternal condition for the majority of the cases in our study is consistent with the findings for antepartum deaths in South Africa (41.9%), the United Kingdom (54.2%) and Zambia (42.9%); intrapartum deaths in South Africa (32.4%) and the United Kingdom (38.7%); and neonatal deaths in the United Kingdom (46.5%). The most important difference is found in neonatal mortality in South Africa and Zambia, where there was a higher association with complications of labor and delivery (39.5 and 53.5%, respectively). The Sri Lanka study does not discriminate deaths according to associated maternal causes.

The main limitation of this study was the quality of the primary data source. The low reliability of the information found in death certificates is well known in the literature, even more so in the case of stillbirths, developed countries not being an exception (21, 22). Despite this recognition, this is the

Table 3.
ICD-PM tabulation of perinatal cause of death and maternal conditions broken down according to the time of death for fetuses/neonates under 1000 g of weight and up to 28 days of life. Antioquia, Colombia, 2013-2016

Maternal condition	M1. Complications of placenta, cord and membranes	M2. Maternal complications of pregnancy	M3. Other complications of labor and delivery	M4. Maternal medical and surgical conditions	M5. No maternal condition	Total (%)
Antepartum deaths						
A1. Congenital malformations, deformations and chromosomal abnormalities	2	4	1	1	106	114 (22.4)
A2. Infection	3	4	1	1	2	11 (2.2)
A3. Acute antepartum event (hypoxia)	82	31	6	36	60	215 (42.2)
A4. Other specified antepartum disorders	4	0	0	2	8	14 (2.8)
A5. Disorders related to length of gestation and fetal growth	26	28	16	21	55	146 (28.7)
A6. Antepartum death of unspecified cause	3	5	0	1	0	9 (1.8)
Total (%)	**120 (23.6)**	**72 (14.1)**	**24 (4.7)**	**62 (12.2)**	**231 (45.4)**	**509**
Intrapartum deaths						
I1. Congenital malformations. deformations and chromosomal abnormalities	0	1	1	0	17	19 (10.0)
I2. Birth trauma	0	0	0	0	0	0
I3. Acute intrapartum event	22	21	35	10	17	105 (55.3)
I4. Infection	1	2	0	1	1	5 (2.6)
I5. Other specified intrapartum disorder	0	0	2	0	0	2 (1.1)
I6. Disorders related to fetal growth	0	8	8	3	36	55 (28.9)
I7. Intrapartum death of unspecified cause	0	1	1	2	0	4 (2.1)
Total	**23 (12.1)**	**33 (17.4)**	**47 (24.7)**	**16 (8.4)**	**71 (37.4)**	**190**

Continuation Table 3

Maternal condition	M1. Complications of placenta, cord and membranes	M2. Maternal complications of pregnancy	M3. Other complications of labor and delivery	M4. Maternal medical and surgical conditions	M5. No maternal condition	Total (%)
Early neonatal deaths						
N1. Congenital malformations. deformations and chromosomal abnormalities	0	2	0	0	22	24 (6.4)
N2. Disorders related to fetal growth	0	0	0	1	1	2 (0.5)
N3. Birth trauma	0	0	0	0	1	1 (0.3)
N4. Complications of intrapartum events	0	0	0	0	20	20 (5.3)
N5. Seizures and disorders of cerebral status	0	0	0	0	3	3 (0.8)
N6. Infection	1	0	0	1	42	44 (11.8)
N7. Respiratory and cardiovascular disorders	0	0	4	0	123	127 (34.0)
N8. Other neonatal conditions	0	1	0	0	33	34 (9.1)
N9. Low birthweight and prematurity	13	19	11	8	63	114 (30.5)
N10. Other miscellaneous causes	0	0	0	0	0	0
N11. Neonatal deaths of unspecified cause	0	0	1	2	2	5 (1.3)
Total (%)	**14 (3.7)**	**22 (5.9)**	**16 (4.3)**	**12 (3.2)**	**310 (82.9)**	**374**
Late neonatal deaths						
N1. Congenital malformations. deformations and chromosomal abnormalities	2	0	0	2	8	12 (9.2)
N2. Disorders related to fetal growth	0	0	0	0	0	0
N3. Birth trauma	0	0	0	0	0	0
N4. Complications of intrapartum events	0	0	0	0	0	0
N5. Seizures and disorders of cerebral status	0	0	0	0	1	1 (0.8)

Continuation Table 3

Maternal condition	M1. Complications of placenta, cord and membranes	M2. Maternal complications of pregnancy	M3. Other complications of labor and delivery	M4. Maternal medical and surgical conditions	M5. No maternal condition	Total (%)
N6. Infection	2	0	0	0	33	35 (26.7)
N7. Respiratory and cardiovascular disorders	0	1	0	2	15	18 (13.7)
N8. Other neonatal conditions	0	2	0	0	35	37 (28.2)
N9. Low birthweight and prematurity	3	6	0	7	7	23 (17.6)
N10. Miscellaneous causes	0	0	0	0	0	0
N11. Neonatal death of unspecified cause	0	0	0	0	5	5 (3.8)
Total (%)	**7 (5.3)**	**9 (6.9)**	**0**	**11 (8.4)**	**104 (79.4)**	**131**

information traditionally used for decision-making and for international comparison and consolidation of information (23). Colombia is a country considered to have high quality records of vital statistics, which plays in favor of this study (24, 25). However, verification of the reliability of the causes of death is not included among the criteria used to assign this rating (23). This evaluation must be a next step in the process of implementing the classification system. The analysis carried out reinforces the need to continue working on improving the quality of vital statistics records. Thorough completion of the records will increase clarity and the specificity of the cause analysis, resulting in improved interventions.

Implications for research and practice: The use of databases with vital records as a source of information to characterize the causes of perinatal death with the ICD-PM system is recommended as a crucial step to propose focused interventions aimed at achieving the proposed goals. On the other hand, it is feasible to break down this information according to some categories that may contribute to decision-making, for example, by territorial divisions, health insurance affiliation, payers, or by healthcare institutions.

CONCLUSION

The use of the ICD-PM system based on vital records is applicable and reproducible as a means to characterize perinatal mortality.

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REFERENCES

1. Frøen JF, Friberg IK, Lawn JE, et al. Stillbirths: Progress and unfinished business. Lancet. 2016; 387 (10018):574-86. https://doi.org/10.1016/S0140-6736(15)00818-1
2. DarmstadtGL,KinneyMV,ChopraM,etal.Whohas been caring for the baby? Lancet. 2014;384(9938):174- 88. https://doi.org/10.1016/S0140-6736(14)60458-X.

3. Black R, Laxminarayan R, Temmerman M, Walker N, editors. Disease Control Priorities, Third Edition (Volume 2): Reproductive, Maternal, Newborn, and Child Health. Washington, DC: The World Bank; 2016. 419 p. https://doi.org/10.1596/978-1-4648-0348-2
4. United Nations. Transforming our world: The 2030 Agenda for Sustainable Development. 2015. Available in: https://sustainabledevelopment.un.org/ post2015/ transformingour world
5. World Health Organization. Every newborn: an action plan to end preventable deaths. Geneva; 2014. 55 p. Available in: https://apps.who.int/iris/bit- stream/ handle/10665/127938/9789241507448_eng. pdf?sequence=1
6. International Stillbirth Alliance Collaborative for Improving Classification of Perinatal Deaths, Flenady V, Wojcieszek AM, et al. Classification of causes and associated conditions for stillbirths and neonatal deaths. Semin Fetal Neonatal Med. 2017;22(3):176-85. https://doi.org/10.1016/j.siny.2017.02.009
7. Leisher SH, Teoh Z, Reinebrant H, Allanson E, Blencowe H, Erwich JJ, et al. Seeking order amidst chaos: Systematic review of classification systems for causes of stillbirth and neonatal death, 2009-2014. BMC Pregnancy Childbirth. 2016;16(1):295. Available in: https://bmcpregnancychildbirth.biomedcentral. com/ track/pdf/10.1186/s12884-016-1071-0 https:// doi.org/10.1186/s12884-016-1071-0
8. World Health Organization. The WHO application of ICD-10 to deaths during the perinatal period: ICD-PM. Geneva; 2016. 88 p.
9. Allanson E, Tunçalp Ö, Gardosi J, Pattinson RC, Erwich JJH, Flenady VJ, et al. Classifying the causes of perinatal death. Bull World Health Organ. 2016;94(2):79-79A. Available in: https://www.ncbi.nlm.nih.gov/ pmc/articles/PMC4750440/pdf/BLT.15.168047.pdf. https://doi.org/10.2471/BLT.15.168047
10. Gobernación de Antioquia. Departamento Administrativo de Planeación. Anuario estadístico de Antioquia 2016-2017. Available in: http://www.antioquiada- tos.gov.co/index.php/salud-publica
11. Organización Panamericana de la Salud (OPS). Clasificación estadística internacional de enfermedades y problemas relacionados con la salud. Vol. 2: Manual de instrucciones. Washington, D.C.: Pan American Health Organization; 1995. 179 p.
12. Black RE, Cousens S, Johnson HL, et al. Global, regional, and national causes of child mortality in 2008: A systematic analysis. Lancet. 2010;375(9730):1969-87. https://doi.org/10.1016/S0140-6736(10)60549-1
13. Lawn JE, Osrin D, Adler A, Cousens S. Four million neonatal deaths: Counting and attribution of cause of death. Paediatr Perinat Epidemiol. 2008;22(5):410-6. Available in: https://www.ncbi.nlm.nih.gov/ pmc/articles/PMC3428888/pdf/ukmss-47778.pdf; doi:10.1111/j.1365-3016.2008.00960.x
14. Ministerio de Salud de Colombia. Resolución 8430 de 1993. Santafé de Bogotá D.C; 1993. p. 19.
15. Barros FC, Bhutta ZA, Batra M, Hansen TN, Victora CG, Rubens CE. Global report on preterm birth and stillbirth (3 of 7): Evidence for effectiveness of interventions. BMC Pregnancy Childbirth. 2010;10(Suppl 1):S3. Available in: http://www.ncbi.nlm.nih.gov/pmc/ articles/PMC2841444/pdf/1471-2393-10-S1-S3.pdf; https://doi.org/10.1186/1471-2393-10-S1-S3
16. Allanson ER, Tunçalp Ö, Gardosi J, et al. The WHO application of ICD-10 to deaths during the perinatal period (ICD-PM): Results from pilot database testing in South Africa and United Kingdom. BJOG. 2016;123(12):2019-28. Available in: https://obgyn. onlinelibrary.wiley.com/doi/epdf/10.1111/1471-0528.14244; https://doi.org/10.1111/1471-0528.14244
17. Allanson ER, Vogel JP, Tunçalp Ö, et al. Application of ICD-PM to preterm-related neonatal deaths in South Af- rica and United Kingdom. BJOG. 2016;123(12):2029.
18. Lavin T, Allanson ER, Nedkoff L, Preen DB, Pattinson RC. Applying the international classification of diseases to perinatal mortality data, South Africa. Bull World Health Organ. 2018;96(12):806-16. Available in: https://www.ncbi.nlm.nih.gov/pmc/articles/

PMC6249699/pdf/BLT.17.206631.pdf; https://doi.org/10.2471/BLT.17.206631

19. Miyoshi Y, Matsubara K, Takata N, Oka Y. Baby survival in Zambia: Stillbirth and neonatal death in a local hospital setting. BMC Pregnancy Childbirth. 2019;19(1):90. Available in: https://bmcpregnancychildbirth.biomedcentral.com/articles/10.1186/s12884-019-2231-9; https://doi.org/10.1186/s12884-019-2231-9
20. Priyani AAH, Thuvarakan P, De Silva MVC. Classification of perinatal deaths according to ICD-PM: An audit on perinatal post-mortems in a tertiary care centre in Sri Lanka. Sri Lanka J Obstet Gynaecol. 2017;39(2):31. Available in: https://sljog.sljol.info/article/10.4038/sljog.v39i2.7811/; https://doi.org/10.4038/sljog. v39i2.7811
21. Christiansen-Lindquist L, Silver RM, Parker CB, et al. Fetal death certificate data quality: A tale of two U.S. counties. Ann Epidemiol. 2017;27(8):466-71.e2. Available in: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5610070/pdf/nihms894248.pdf; https://doi.org/10.1016/j.annepidem.2017.07.001
22. Cockerill R, Whitworth MK, Heazell AE. Do medical certificates of stillbirth provide accurate and useful information regarding the cause of death? Paediatr Perinat Epidemiol. 2012;26(2):117-23. https://doi.org/10.1111/j.1365-3016.2011.01247.x
23. Liu L, Johnson HL, Cousens S, et al. Global, regional, and national causes of child mortality: An updated systematic analysis for 2010 with time trends since 2000. Lancet. 2012;379(9832):2151-61. https://doi.org/10.1016/S0140-6736(12)60560-1
24. Lawn JE, Blencowe H, Oza S, et al. Every newborn: Progress, priorities, and potential beyond survival. Supplementar y appendix. Lancet. 2014;6736(14):1-79. https://doi.org/10.1016/S0140-6736(14)60496-7
25. Oza S, Lawn JE, Hogan DR, Mathers C, Cousens SN. Neonatal cause-of-death estimates for the early and late neonatal periods for 194 countries: 2000-2013. Bull World Health Organ. 2015;93(1):19-28. Available in: http://www.who.int/entity/bulletin/volumes/93/1/14-139790.pdf; https://doi.org/10.2471/BLT.14.139790.

AUTHOR CONTRIBUTIONS

Mary Salazar-Barrientos: Proposal conception and design, adjustments to the database, creation and implementation of formulas in the data management software, data analysis, drafting of the manuscript and approval of the final version.

John Jairo Zuleta-Tobón: Proposal conception and design, clinical interpretation of the data, data analysis, drafting of the manuscript and approval of the final version.

Conflict of interest: The authors participate as contractors in the epidemiological surveillance processes implemented by the Antioquia Health and Social Protection Secretariat, including perinatal mortality analysis