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Epidemiological and care characteristics and spatial distribution of deaths due to congenital syphilis

Características epidemiológicas, assistenciais e distribuição espacial dos óbitos por sífilis congênita

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Abstract

Objective: To describe the epidemiological and care characteristics and investigate the spatial distribution of deaths due to congenital syphilis (CS). **Methods:** A descriptive and mixed study with a quantitative and ecological approach was conducted. The investigation and summary records of fetal and infant deaths due to CS registered in the Mortality Information System of Recife between 2013 and 2017 were analyzed. Mortality rates and relative and absolute frequencies were calculated. For spatial analysis, the health districts, areas covered by the Family Health Strategy (FHS), and place of the deaths were superimposed; the kernel density estimator was adopted. **Results:** A total of 2,437 deaths were found: 1,119 (45.9%) were fetal, and 1,318 (54.1%) were infant. Only 198 (8.1%) of the deaths were due to CS, of which 173 (87.4%) were fetal and 25 (12.6%) were infant. The mean fetal and infant mortality rates were 9.7 and 11.5 per 1,000 live births, respectively. In contrast, the mean fetal and infant mortality rates related to CS were 1.5 and 0.2 per 1,000 live births, respectively. A total of 27 (77.1%) out of 35 deaths due to CS in 2017 received prenatal care; of these, 14 (51.8%) started in the second trimester of pregnancy. The mapping showed clusters of deaths in most health districts of areas covered by the FHS. **Conclusion:** The mortality due to CS is associated with the quality of pre-

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natal care, indicating weaknesses in the performance and organization of healthcare teams.

Keywords: Congenital syphilis; Child mortality; Fetal mortality; Prenatal care; Spatial analysis.

Resumo

Objetivo: Descrever as características epidemiológicas e assistenciais e a distribuição espacial dos óbitos por sífilis congênita (SC). **Métodos:** Estudo misto, ecológico e descritivo com abordagem quantitativa. Foram analisados todos os registros no Sistema de Informação sobre Mortalidade de **óbitos fetais e infantis por** SC em parturientes residentes no Recife-PE ocorridos entre 2013 e 2017, assim como suas fichas de investigação e fichas síntese. Os coeficientes de mortalidade foram calculados, bem como a frequência relativa e absoluta. Para a análise espacial, foram sobrepostas as camadas de distritos sanitários, as **áreas** atendidas pela Estratégia de Saúde da Família e as residências dos óbitos estudados, e foi adotado o estimador de densidade de Kernel. **Resultados:** Constatou-se a ocorrência de 2.437 óbitos, sendo 1.119 (45,9%) fetais e 1.318 (54,1%) infantis. Dos óbitos analisados, 198 (8,1%) foram por SC, sendo 173 (87,4%) fetais e 25 (12,6%) infantis. O coeficiente médio de mortalidade fetal foi de 9,7 por 1.000 nascimentos, e o infantil foi de 11,5 por 1.000 nascidos vivos. J**á o coeficiente** médio de mortalidade fetal por SC foi de 1,5 por 1.000 nascimentos, e o infantil foi de 0,2 por 1.000 nascidos vivos. Para os óbitos por SC ocorridos em 2017 (35), verificou-se que 27 (77,1%) receberam assistência ao pré-natal, sendo que, desses, 14 (51,8%) só tiveram o início da assistência ao pré-natal no 2° trimestre da gestação. No mapeamento, observou-se aglomerados de óbitos na maioria dos distritos sanitários e que esses estão concentrados em áreas atendidas pela Estratégia de Saúde da Família. **Conclusão:** A persistência da mortalidade por SC está relacionada **à** qualidade da assistência ao pré-natal, o que aponta fragilidades na atuação e na organização das equipes.

Palavras-chave: Sífilis congênita; Cuidado pré-natal; Mortalidade fetal; Mortalidade infantil; Análise espacial.

INTRODUCTION

Congenital syphilis (CS) is a public health issue worldwide. This disease results from the hematogenous transmission of the *Treponema pallidum* in an infected pregnant woman via a transplacental route. CS can be transmitted in any trimester of pregnancy and is responsible for nearly 40% of the perinatal mortality rate, 25% of fetal deaths, and 14% of infant deaths globally[1]. Its vertical transmission is preventable, given the early diagnosis and adequate treatment of the pregnant woman. Thus, prenatal care is crucial to reduce negative outcomes[2].

A study indicated that late initiation of prenatal care, difficulties in diagnosing syphilis during pregnancy, failure to treat the pregnant woman and her partner, and the absence of orientation about the disease and its prevention represent gaps in the provided prenatal care. These factors

reinforce that the understanding of vertical transmission is essential to ensure the quality of prenatal care[3].

A satisfactory prenatal care should include at least six medical appointments, starting in the first trimester of pregnancy. Syphilis testing is highly recommended in the first and third trimesters and before birth[4]. Although the healthcare network provides the means for disease control, socioeconomic, political, and individual factors may hinder population access, favoring CS in vulnerable groups[5, 6].

Studies showed that low income and education level, drug abuse, and history of sexually transmitted infections are risk factors for CS. Furthermore, the lack of partner support during pregnancy, single mothers with multiple partners, or unintended pregnancies may hinder access to prenatal care, favoring CS infection. These vulnerabilities may also influence late prenatal care and lead women to attend fewer medical appointments, reducing the chance of screening for the disease in the first semester[7, 8, 9].

In this context, health departments have been adopting spatial analysis via geoprocessing to understand the characteristics related to the dynamics of CS in the territory and develop interventions to address the disease. Spatiotemporal distribution verifies the spatial patterns of the disease, health services, and the environment. Thus, diseases can be mapped, aggregations detected, and potential risk areas identified to properly guide resource allocation and define target groups for intervention[10, 11].

This study aimed to describe the epidemiological and care characteristics and investigate the spatial distribution of deaths due to CS in Recife (Pernambuco, Brazil) between 2013 and 2017.

METHODS

A mixed and descriptive study was performed in Recife (Pernambuco), northeastern Brazil, using a quantitative and ecological approach. Recife has an area of 218,435 km² and a population of 1,637,834 distributed across 94 neighborhoods and divided into 8 health districts (HD). The estimated population coverage for primary care is 73%, of which 58% is covered by the Family Health Strategy (FHS) and 14.5% by community health agents. The network of specialized healthcare consists of 18 maternity hospitals, and four of these are managed by the Recife Health Department[12].

Fetal and infant deaths due to CS in Recife between 2013 and 2017 were obtained from the Mortality Information System (SIM). Specifically for 2017, the confidential investigation form and the summary form were used in addition to the SIM to monitor fetal and infant deaths. These data were used to characterize the care provided during prenatal and birth, as well as the occurrence of death. The forms were analyzed until 2017 because this was the last year with complete

records related to death at the time of this study. Data from the mother, pregnancy, and childbirth were also obtained from the SIM.

Data from the SIM were processed and analyzed using the TabWin and Excel® 2013 software. A database was created using the Epinfo software (version 7.2.3.1) to collect data from the forms. Absolute and relative frequencies and fetal, infant, perinatal (total fetal deaths at ≥ 22 pregnancy weeks and deaths of infants aged from zero to six complete days), and total mortality rates related to CS were calculated.

Spatial analysis was carried out using cartographic bases of HD and the FHS coverage. The place of residence where deaths occurred was georeferenced using the Google Earth Pro. Based on geographic coordinates and the Qgis 2.18 software, the kernel density estimator was applied. This parameter creates continuous surface maps and provides estimates of the occurrence across the analyzed area. These estimates are also independent of administrative boundaries and consider the number of occurrences in a defined coverage radius, assigning greater scores to closer points and reducing the importance of distant points.

This study was approved by the human research ethics committee of the Professor Fernando Figueira Institute of Integral Medicine under registration number 3285689.

RESULTS

A total of 2,437 deaths were recorded: 1,119 (45.9%) fetal and 1,318 (54.1%) infant. Of these, 198 (8.1%) were due to CS, of which 173 (87.4%) were fetal and 25 (12.6%) were infant deaths. The mean fetal mortality rate was 9.7 per 1,000 births, whereas the infant mortality rate was 11.5 per 1,000 live births. The mean fetal and infant mortality rates due to CS were 1.5 and 0.2 per 1,000 live births, respectively (Table 1).

Table 1. Fetal, infant, perinatal, and CS mortality rates by year.
Recife (Pernambuco, Brazil), 2013 to 2017.

Year	Fetal				Infant				Perinatal			
	Total		SC		Total		SC		Total		SC	
	N°	CM	Nº	CM	N°	CM	N°	CM	N°	CM	N°	CM
2013	235	10.0	36	1.5	288	12.4	8	0.3	354	15.1	42	1.8
2014	228	9.6	32	1.3	280	12.0	5	0.2	348	14.7	33	1.4
2015	221	9.2	34	1.4	248	10.5	2	0.1	332	13.9	33	1.4
2016	219	10.1	38	1.7	255	12.0	8	0.4	328	15.2	41	1.9
2017	216	9.4	33	1.4	247	11.0	2	0.1	329	14.3	29	1.3
Total	1119	9.7	173	1.5	1318	11.5	25	0.2	1691	14.6	185	1.6

Fetal and perinatal mortality rates per 1,000 births; infant mortality rate per 1,000 live births.
MR = mortality rate; CS = congenital syphilis.

Moreover, 1,691 perinatal deaths were recorded; 185 (10.9%) were due to CS. The mean perinatal mortality rate (PMR) was 14.6 per 1,000 births, and the mean PMR due to CS was 1.6 per 1,000 births (Table 1); most were observed in pregnant women aged from 20 to 34 years (n = 108; 58.3%).

Regarding education level, over half of the deaths (n = 143; 77.3%) were related to mothers who complete high school and were without income (n = 140; 75.7%). Regarding the PMR, a higher risk of death due to CS was observed in pregnant women aged < 19 years (3.4 per 1,000 births), with complete high school (2.3 per 1,000 births), and without income (2.2 per 1,000 births) (Table 2).

Table 2. Sociodemographic, epidemiological, clinical, and care profile of pregnant women and their infants who suffered perinatal death due to CS. Recife, Pernambuco, Brazil, 2013 to 2017

Variables	N	%	PMR*
Age group			
< 19 years	63	34.0	3.4
20 to 34 years	108	58.3	1.3
≥ 35 years	14	7.5	1.4
Education level			
No education	0	-	-
Elementary school	7	3.8	1.4
Middle school	27	14.6	1.0
High school	143	77.3	2.3
Bachelor's degree	2	1.1	0.1
Ignored	6	3.2	-
Occupation			
With remuneration	41	22.2	0.7
Without remuneration	140	75.7	2.3
Ignored	4	2.1	-
History of previous pregnancies** (1)			
Live births	124	67.0	-
Fetal losses and abortions	104	56.2	-
Ignored	2	1.0	-
Gestational week at birth			
Premature (< 37weeks)	166	89.7	11.8
Full-term (≥ 37 weeks)	19	10.3	0.2
Type of pregnancy			
Single	181	97.8	1.6
Twin	4	2.2	1.6
Type of birth			
Vaginal	168	90.8	3.1
Cesarean	15	8.1	0.2
Ignored	2	1.1	-

Sex of the infant			
Male	95	51.3	1.6
Female	87	43.8	1.5
Ignored	3	1.5	-
Race of the infant** (1)			
Non-black (white)	1	4.7	-
Black (black + brown)	17	81.0	-
Ignored	3	16.0	-
Weight at birth			
Low (< 2500 g)	148	80.0	15.0
Normal (≥ 2500 g)	34	18.4	0.3
Ignored	3	1.6	-

* Ignored variables were excluded from the calculation.
**Variable with more than one answer.
***Only for infant deaths.
(1) Perinatal mortality rate was not calculated for this variable.
CS = congenital syphilis; PMR = perinatal mortality rate.

Among all perinatal deaths due to CS, over half of pregnant women (n = 104; 56.2%) had a previous fetal loss or abortion. Most of these deaths were observed from premature births (n = 166; 89.7%, PMR of 11.8 per 1,000 births), single pregnancies (n = 181; 97.8%, PMR of 1.6 per 1,000 births), and vaginal birth (n = 168; 90.8%, PMR of 3.1 per 1,000 births). Additionally, 95 (51.3%) deaths due to CS occurred in male infants and with low weight at birth (n = 148; 80.0%, PMR of 15.0 deaths per 1,000 births). Furthermore, 17 (81.0%) deaths occurred in infants assigned as black (Table 2).

In 2017, 35 deaths due to CS were registered; 27 (77.1%) pregnant women received prenatal care. Fourteen (51.8%) of these women initiated prenatal care in the second trimester of pregnancy, and 23 (85.1%) received care at a basic health unit through the FHS. Furthermore, 23 (85.2%) pregnant women attended fewer than six prenatal appointments (Table 3).

Among the pregnant women who received prenatal care, seven (25.9%) were tested for syphilis and six (22.2%) did not undergo any testing. However, the investigation and summary forms of 14 (51.9%) deaths lacked records of syphilis testing, and 20 (74.1%) had no information concerning visits by a community health agent (Table 3).

All births occurred in hospitals or maternities: 33 (94.3%) were public healthcare facilities, 30 (85.7%) were premature births, and 33 (94.3%) were from single pregnancies. Additionally, 30 (85.7%) were vaginal births, and 100% underwent a rapid syphilis testing (Table 3).

Table 3. Characteristics of prenatal care, birth, and fetal and infant deaths due to CS. Recife, Pernambuco, Brazil, 2017.

Section	Variables	N	%
Perinatal	**Complete prenatal care**		
	Yes	27	77.1
	No	8	22.9
	Start of prenatal care		
	First trimester	8	29.6
	Second trimester	14	51.8
	Third trimester	4	14.8
	Ignored	1	3.7
	Facility where prenatal care was conducted		
	Family Health Strategy	23	85.1
	High-risk prenatal care unit	1	3.7
	Multiple facilities	1	3.7
	Ignored	2	7.4
	Number of medical appointments		
	< 6	23	85.2
	≥ 6	4	14.8
	Testing for syphilis		
	Yes	7	25.9
	No	6	22.2
	Ignored	14	51.9
	Visit from a community health agent during pregnancy		
	Yes	7	25.9
	Ignored	20	74.1
Birth	**Place of birth**		
	Hospital/maternity	35	100.0
	Other health facilities	0	-
	Gestational age		
	Premature (< 37 weeks)	30	85.7
	Full-term (≥ 37 weeks)	4	11.4
	Ignored	1	2.8
	Type of pregnancy		
	Single	33	94.3
	Twin	2	5.7
	Rapid syphilis testing at the maternity		
	Yes	35	100.0
	No	0	-
	Type of birth		
	Vaginal	30	85.7
	Cesarean	5	14.3
	Time spent by the newborn in the maternity*		
	≥ 28 days	1	50.0
	Ignored	1	50.0

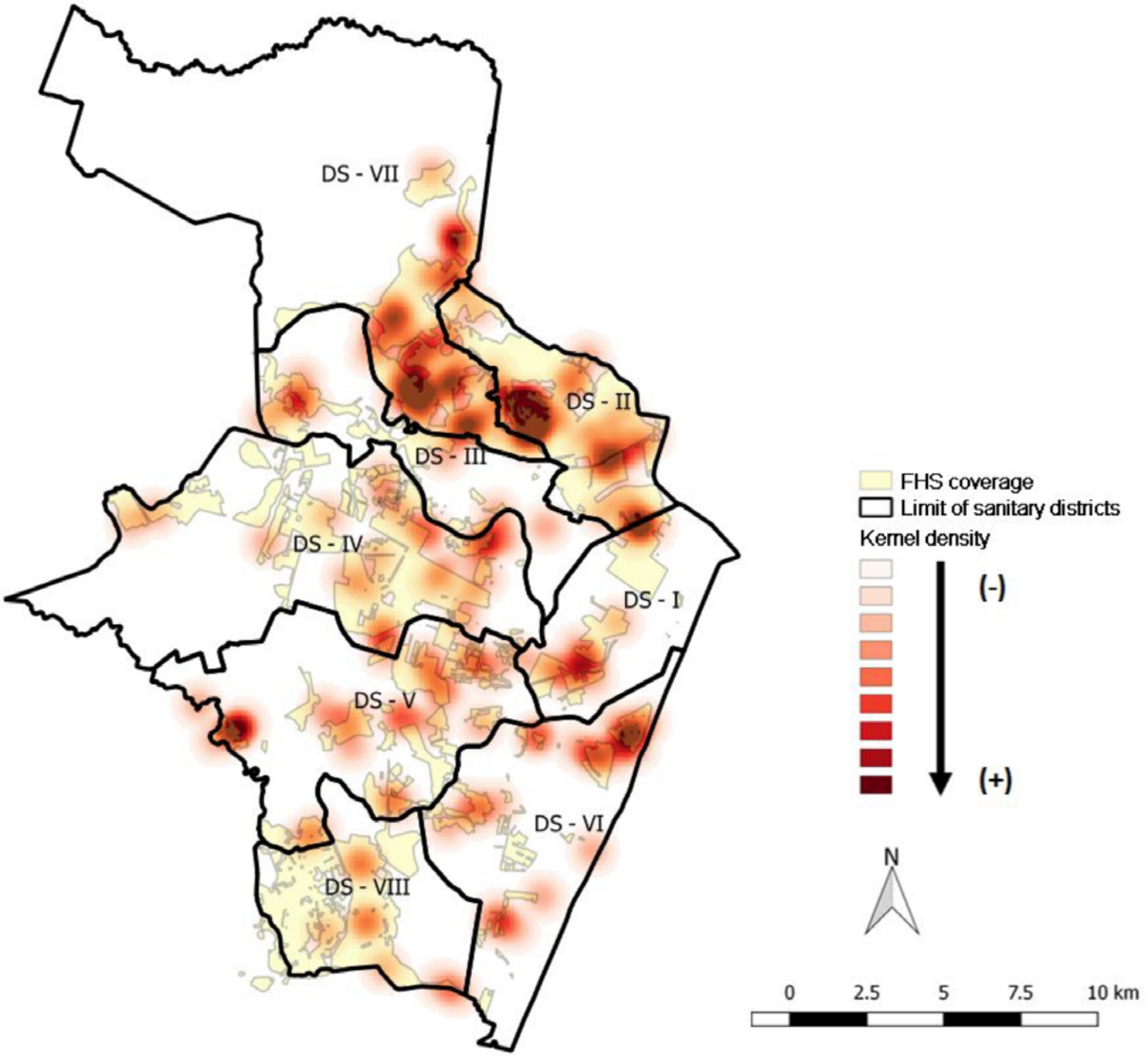
Occurrence of death	**Place of death**		
	Hospital/maternity	35	100.0
	Other health facilities	0	-
	Type of facility		
	Public	33	94.3
	Private	2	5.7

*Infant death.

CS = congenital syphilis .

Although fetal and infant deaths due to CS were observed throughout the territory of Recife, a higher density was found in the adjacency of the HD II and VII (north of the city). Death clusters were observed in the central region of the city (HD I), which is predominantly commercial, has a lower demographic density, and is mostly composed of a socially vulnerable population. Places of residence with deaths due to CS were mainly observed in unfavored socioeconomic regions of the HD V (west) and VI (south), which are areas with high population density. Interestingly, all clusters were identified in regions covered by the FHS (Figure 1).

Figure 1. Spatial distribution of fetal and infant deaths due to congenital syphilis. Recife (Pernambuco, Brazil), 2013 to 2017.



Source: Authors.

DISCUSSION

In Recife, the PMR due to CS was 1.6 per 1,000 births; more than 85% were fetal deaths. Studies performed in all Brazilian regions showed that fetal and infant mortality rates due to CS indicated precarious basic maternal and infant care, reinforcing the hypothesis that these deaths could predict the quality of prenatal care[13, 14].

As CS is a preventable disease, a minimum threshold for mortality rate does not exist.

Thus, any death is unacceptable and indicates a failure in the public healthcare system. Nevertheless, the Pan American Health Organization and the Brazilian defined a rate of 0.5 per 1,000 live births as goal to eradicate CS[15] Ministry of Health[16].

Although most perinatal deaths from CS were observed in pregnant women aged from 20 to 34 years, the highest risk was detected in women aged < 19 years with completed high school and without income[17]. A study conducted in the state of Paraná (Brazil) demonstrated that adolescents were more susceptible to contracting syphilis due to developmental and emotional immaturity and early sexual activity without contraceptive methods. Additionally, pregnancy during adolescence often impair or interrupts education, hindering access to paid work[17].

Also, most perinatal deaths from CS were observed in infants assigned as black race. Race is a risk factor for infant death due to its association with the social context, both affected by limited access to healthcare services. The relationships between race and sociodemographic characteristics of the mother indicate that this profile is generally associated with an unfavorable socioeconomic condition and minimum access to healthcare services[17, 18].

Most deaths due to CS were observed in women with a history of fetal losses and abortions. Depending on the cause, the risk of fetal death in the following pregnancies is two to ten times higher, and fetal death in multiparous women is associated with a highly active syphilis[19].

Prematurity and low weight at birth must be highlighted in this study because of the higher risk of perinatal death due to CS. Low weight at birth may be associated with prematurity since it is considered an adverse event of CS. Death before 37 weeks of pregnancy depend on the stage of maternal infection and gestational age at which vertical transmission occurred, highlighting the importance of prevention. Therefore, testing for syphilis in the first trimester (especially at the first appointment) and at the beginning of the third trimester is essential. Nevertheless, when diagnosis cannot be performed, immediate treatment of the pregnant woman and her partner is recommended to prevent reinfection[4, 17].

The analysis of prenatal care in 2017 indicated that over a quarter of fetal and infant deaths did not receive treatment. However, 77% of the pregnant women received prenatal care, primarily through the FHS. This finding suggests a weakness in prenatal care, as over half of the pregnant women initiated it in the second trimester and attended fewer appointments than recommended by the Ministry of Health, hindering diagnosis and appropriate treatment. This result supports the findings of a study conducted in the state of Minas Gerais (Brazil), which correlated CS and late prenatal care to the failure to diagnose the disease in the first trimester of pregnancy[8].

Despite the high FHS coverage, prevention measures for CS are still poor. Specialized prenatal care is essential to reduce CS mortality[20]. Appropriate management to prevent vertical transmission involves early detection and appropriate treatment. In this sense, an active search

for pregnant women in the communities is needed to initiate prenatal care by the 12th week of pregnancy and implement interventions recommended by the Ministry of Health to timely eliminate maternal syphilis and vertical transmission. Promoting health and sexual and reproductive orientation is also necessary[17, 19].

In this study, many women ignored the question regarding syphilis testing during pregnancy and visits by a community health agent. These prenatal variables assessed in the form are important to investigate fetal and infant death, ensure a better understanding of the provided prenatal care, allow for a correct classification of preventable deaths, and propose measures to prevent further deaths[16, 21].

Although few participants responded to the question related to syphilis testing in the forms, 22.2% of the pregnant women who received prenatal care did not undergo any testing. This may indicate a failure in prenatal care since rapid and efficient testing for syphilis is available in healthcare services. Syphilis testing provides early access to syphilis results; thus, allowing for an early treatment even if the pregnant woman attends fewer appointments than recommended[22].

All pregnant women were tested for syphilis at the maternity hospital, following the recommendations of the Ministry of Health. Although birth is not the appropriate moment for diagnosis, the protocol includes treponemal and nontreponemal tests to indicate the best approaches for the mother and newborn[23].

The mapping of fetal and infant deaths from CS highlighted clusters in most HD. Recife has a territory composition that ranges from highly economically valued areas to structurally unfavored areas. Special zones of social interest with low-income populations and social and infrastructural vulnerability can also be identified in the territory[12].

This heterogeneity explains the distribution of CS throughout the territory and indicates social vulnerability as risk factor to death. A study conducted in the state of Rio de Janeiro (Brazil) indicated that limited access to services, education, work, and culture increased social vulnerability, reduced responsiveness in risk situations, and increased illnesses among the population[24].

Nonetheless, the result showed that most deaths occurred in areas covered by the FHS, which suggests problems in team performance or organization of the healthcare system that may compromise the quality and efficiency of the prenatal care provided[10].

The resoluteness of primary care depends on ordination in the work process and personnel capacitation to identify and attend to user needs[25]. A study conducted in Fortaleza (Ceará, Brazil) showed that some professionals from family health units were unaware of preventive measures to control CS[26]. Another study carried out in Londrina (Paraná, Brazil) also highlighted that insufficient knowledge of healthcare professionals in preventing vertical transmission hindered efforts to counter CS during prenatal care[27].

As the FHS is essential to counter vertical transmission, investing in permanent education to healthcare professionals may help develop adequate management practices and change the epidemiology scenario[28]. In the state of Paraná, an educational intervention for health professionals of basic health units improved prenatal care, indicated by a decrease in CS transmission and mortality rates[27].

The present study has limitations related to the use of secondary data, which depended on the quality of previous records. Despite this, the database and forms used were reliable, of good quality, and contained trustworthy information[29]. Nevertheless, the lack of studies investigating fetal, infant, and perinatal deaths due to CS using georeferencing tools underscores the importance of this study.

CONCLUSION

Fetal and infant deaths from CS were observed mostly in black pregnant women aged < 19 years with complete high school and without income. Although most women received prenatal care through the FHS, over half of them started late and had fewer appointments than recommended. A concentration of deaths was observed in areas close to the FHS, suggesting weaknesses in team performance and systematization of health services; thus, impairing maternal and infant qualified healthcare.

The mortality due to CS is not only associated to primary care coverage but also to the quality of primary care provided. This is justified by the deaths, which indicates impaired prenatal care and failure to prevent vertical transmission.

COMPETING INTERESTS

The authors declare no competing interests.

AUTHORS CONTRIBUTION

All authors participated in all stages of the manuscript and approved the publication of the final version.

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