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Spatial AnalysisofLethality Dueto Severe Acute Respiratory Syndromeby COVID-19 in Maranhão, Brazil, 2020-2022

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Análise Espacial da Letalidade por Síndrome Respiratória Aguda Grave por COVID-19 no Maranhão, Brasil, 2020-2022

Análisis espacial de la letalidad por síndrome respiratorio agudo severo por COVID-19 en Maranhão, Brasil, 2020-2022

RESUMO

Objetivo: realizar análise da distribuição espacial da letalidade por Síndrome Respiratória Aguda Grave (SRAG) por COVID-19 no Maranhão, de 2020 a 2022. Métodos: Estudo descritivo das taxas de letalidade SRAG por COVID-19 por município de notificação e de residência no Maranhão, a partir de registros no Sistema de Informação da Vigilância Epidemiológica da Gripe (SIVEP-Gripe). Resultados: Foram notificados 3.617 óbitos em 2020, 5.288 em 2021 e 588 em 2022. A taxa de letalidade no período foi de 39,1%, sendo 45,3% em 2020; 36,4% em 2021; e 33,3% em 2022. A taxa de letalidade por município de notificação e de residência foi igual a 100% em 18 (8,2%) e cinco (2,3%) municípios, respectivamente. Não notificaram casos 106 municípios (48,8%), enquanto 129 municípios (59,4%) não registraram óbitos. Conclusão: Os dados sugerem que há sub-registros/sub-notificações de casos e óbitos no SIVEP-Gripe.

DESCRITORES: Infecções por coronavírus; COVID-19; Síndrome respiratória aguda grave (SRAG); Letalidade.

ABSTRACT

Objective: to carry out an analysis of the spatial distribution of lethality due to Severe Acute Respiratory Syndrome (SARS) due to COVID-19 in Maranhão, from 2020 to 2022. Results: 3,617 deaths were reported in 2020, 5,288 in 2021 and 588 in 2022. fatality rate in the period was 39.1%, 45.3% in 2020; 36.4% in 2021; and 33.3% in 2022. The lethality rate by reporting municipality and household was equal to 100% in 18 (8.2%) and five (2.3%) municipalities, respectively. 106 municipalities (48.8%) did not notify cases, while 129 municipalities (59.4%) did not register deaths. Conclusion: The data suggest that there is underreporting/underreporting of cases and deaths in SIVEP-Flu.

DESCRIPTORS: Corona virus infections; COVID-19; Severe acute respiratory syndrome (SARS); Lethality.

RESUMEN

Objetivo: realizar unanálisis de ladistribución espacial de laletalidad por Síndrome Respiratorio Agudo Severo (SRAS) por COVID-19 en Maranhão, de 2020 a 2022. Métodos: Estudio descriptivo de lastasas de letalidad por SARS por COVID-19 por municipio de notificación y residenciaen Maranhão, con base enlos registros del Sistema de Información de Vigilancia Epidemiológica de Influenza (SIVEP-Gripe). Resultados: se reportaron 3.617 defuncionesen 2020, 5.288 en 2021 y 588 en 2022. La tasa de letalidadenel período fue de 39,1%, 45,3% en 2020; 36,4% en 2021; y 33,3% en 2022. La tasa de letalidad por municipio de notificación y residenciafue igual al 100% en 18 (8,2%) y cinco (2,3%) municipios, respectivamente. 106 municipios (48,8%) no notificaron casos, mientras que 129 municipios (59,4%) no registrarondefunciones. Conclusión: Los datossugieren que existe subregistro/subnotificación de casos y defuncionesen SIVEP-Gripe.

DESCRIPTORES: Infecciones por coronavirus; COVID-19; Síndrome respiratorio agudo severo (SARS); Letalidad.

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INTRODUÇÃO

In recent years, we have observed an increase in records and cases of infectious and contagious respiratory diseases, which start suddenly, are difficult to locate and spread rapidly worldwide. [1] We can characterize the Severe Acute Respiratory Syndrome (SARS) as an infectious viral respiratory syndrome caused mainly by the influenza virus and to a lesser extent by other etiological agents that infect the upper respiratory tract. [2]

The clinical picture of SARS is characterized by several symptoms, including tiredness, respiratory discomfort with low oxygen absorption, which leads to a picture of low oxygen saturation, in general less than 95%, which can lead to hospitalization, followed by ventilatory support, admission to the intensive care unit (ICU) and an increase in the occurrence of deaths in hospital beds. [3]

In Brazil, the Information System for the Epidemiological Surveillance of Influenza (SIVEP-Gripe) was established in 2009 to monitor and monitor the records of SARS cases and deaths. This strategy was adopted due to the influenza A H1N1 pandemic, which led to an increase in the number of cases, hospitalizations and deaths from SARS. Currently, notification of records of cases and deaths in hospital units and of SARS-related deaths at home is mandatory in the country. [4]

On March 11, 2020, the World Health Organization (WHO) decreed the global alert for the spread of the severe acute respiratory syndrome virus 2 (SARS-CoV-2), officially starting the COVID-19 pandemic. [5] In Brazil, the first case was registered on February 26, 2020 and the first death 25 days later, with rapid advance across all regions. [6] Until January 4, 2023, 36,362,366 cases and 693,981 deaths from SARS due to COVID-19 were registered, with a lethality rate equal to 1.9%. [7]

In Maranhão, a state in northeastern Brazil, the first case was registered on March 20, 2020 and the first death was confirmed ten days later, in São Luís. [8] The State has 217 municipalities, divided into 19 regional and eight health macro-regions, being considered one of the poorest in the Federation, presenting the worst social and health indicators in the country, including the low supply of hospital beds, especially in the interior municipalities. [9,10] According to the panel of the Ministry of Health (MH) 7, until January 4, 2023, Maranhão had 488,295 cases, 11,035 deaths, with a lethality rate equal to 2.2%, above the national average.

The North and Northeast regions of the country have a smaller hospital structure and accessibility to beds, especially in the ICU, reducing the possibility of providing higher quality care in a timely manner, characterizing an overload on health services. [11] This lack of service provision is defined as "assistance gap", that is, the territorial area that has a deficit in the number of hospital beds for a given population. [12]

In Brazil, accessibility to ICU beds during the COVID-19 pandemic was correlated with the severity of cases and the consequent increase in the number of deaths, as only 250 municipalities had rates of beds per inhabitant at an acceptable rate (<0.001075 beds/inhabitant). In Maranhão, this rate is equal to 0.0016034, below the national average (0.0018219), although above the average for the Northeast region (0.001592). However, most of these beds are concentrated in the regions of São Luís, Imperatriz and Caxias, characterizing the lack of care in other regions of the State. [13]

In this way, the objective of this article is to carry out the analysis of the spatial distribution of SARS lethality by COVID-19 in Maranhão, considering the municipality of notification and the municipality of residence, in the years 2020 to 2022, based on the SIVEP-Gripe records.

METHODS

This is an ecological study of the distribution of lethality rates due to SARS due to COVID-19, according to the municipality of notification and residence in Maranhão, from March 2020 to December 2022, based on SIVEP-Gripe records.

SIVEP-Gripe is the official system for recording SARS cases and deaths in the country, including deaths at home. The Ministry of Health has carried out SARS surveillance since the Influenza A (H1N1) pandemic in 2009. As of that date, SARS surveillance was implemented in the surveillance network for Influenza and other respiratory viruses and, in 2020, SARS surveillance for COVID-19 was incorporated as mandatory notification. Notification of cases is carried out through the "Individual Registration Form for SARS Cases". [14]

The study population consisted of all cases and deaths due to SARS due to COVID-19, which occurred in the period from March 2020 to December 2022, residing and hospitalized/hospitalized in the municipalities of Maranhão, registered in the SIVEP-Gripe. Cases and deaths registered from other federative units were not included, as well as those classified as discarded, or as SARS due to another cause or etiological agent.

Records of patients from other municipalities from other federative units and who were admitted to hospitals in Maranhão were excluded, covering only those residents and notified in the State itself.

For notification, SARS cases are considered, and individuals with a combination of the following symptomatic conditions must be compulsorily notified (SIVEP-Gripe, 2020) 14:

1) High fever (above 37,8ºC) AND

2) Cough OR sore throat AND

3) Breathing difficulty OR dysp-

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nea OR O2 saturation < 95% AND

4) Required hospitalization OR died having presented the referred symptoms, regardless of hospitalization.

The final classification by SARS in SIVEP-Gripe is based on the following criteria: laboratory, clinical epidemiological; only clinical and clinical-imaging. SARS can then be classified according to the etiological agent: 1) influenza virus; 2) another respiratory virus; 3) another etiologic agent; 4) unspecified; or 5) SARS due to COVID-19, only the latter being used in this work. [14]

Information available online from the SIVEP-Gripe SARS database (https://opendatasus.saude.gov.br/dataset) was used, up to the update available on December 26, 2022.

The following variables from the Individual Registration Form for SARS cases due to COVID-19 were used: city of notification, hospitalization/hospitalization, municipality of residence, gender, age, race/color, risk factor, hospitalization, admission to the Intensive Care Unit (ICU), ventilatory support and evolution to death (yes or no). [14]

For the calculation of the lethality rate and for the spatial analysis, cases and deaths due to SARS due to COVID-19 of people residing and hospitalized/hospitalized in municipalities of Maranhão were considered, with reference to studies carried out throughout the country [4,15], in the States of Pernambuco, Bahia and Piauí [11,16,17], and in four capitals of federal units [18]

a) lethality rate by municipality of notification: ratio between the number of deaths and the number of notifications, in the municipality of admission/hospitalization, in the SIVEP-Gripe records, by year of occurrence, multiplied by 100.

b) lethality rate by municipality of residence: ratio between the number of deaths and the number of notifications, according to the municipa-

lity of residence, in the SIVEP-Gripe records, by year of occurrence, multiplied by 100.

The data were imported into the R statistics programming language, installed in the "RStudio" software, version 4.2.1, from the SIVEP-Gripe online database.

Subsequently, they were submitted to descriptive statistical analysis, including absolute and relative frequencies. Death records from COVID-19 were aggregated by a municipal unit in the State of Maranhão for the year 2020.

To analyze the location and pattern of the spatial distribution of deaths from COVID-19, the geoprocessing available in the "geobr" package of the "RStudio" software, automatically defined by the IBGE, was used. This software was also used for data manipulation and map plotting to visualize the results.

This study was approved by the Research Ethics Committee (CEP) of the University Hospital of the Federal University of Maranhão (HUUFMA) and by the National Research Ethics Committee (CONEP) under Opinion number: 4.098.427 and CAAE 32206620.0.0000.5086, of June 19th, 2020.

RESULTS

Descriptive analysis

In Maranhão, there were 40,016 total records of SARS in the period from 2020 to 2022. There were 12,278 (30.0%) notifications due to unspecified cause or other etiological agent, that were excluded from the analysis because they did not meet the laboratory or clinical criteria for final classification as SARS due to COVID-19.

Of the total number of records, 24,260 (60.6%) presented a final classification by SARS due to COVID-19, with 9,493 deaths, corresponding to a lethality rate of 39.1%. The number of deaths reported from SARS due to COVID-19 was 3,617 in 2020, 5,288 in 2021 and 588 in 2022. The fatality rate for the years was, respectively, 45.3% in 2020; 36.4% in 2021; and 33.3% in 2022 (Table 1).

Of the total deaths in the period (9,493), the majority were male (5,644; 59.5%),

with a predominance of brown race/color (6,844; 72.1%) and with a mean age of 65.9 years (±16.9) (Table 2). Among the deaths, 4,884 (51.4%) were admitted to the ICU; 2,989 (31.5%) used invasive ventilatory support and 6,014 (63.4%) had some type of risk factor during hospitalization (Table 3).

TABLE 1 - NOTIFICATIONS OF CASES AND DEATHS DUE TO SERIOUS ACUTE RESPIRATORY SYNDROME DUE TO COVID-19, MARANHÃO, BRAZIL, 2020-2022								
TOTAL NOTIFICATIONS	**2020**		**2021**		**2022**		**TOTAL**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Notifications of all SARS	15.173	-	20.299	-	4.544	-	40.016	-
SARS notifications for COVID-19	7.973	52,5	14.525	71,5	1.762	38,7	24.260	60,6
SARS deaths from COVID-19 Lethality (%)	3.617	45,3	5.288	36,4	588	33,3	9.493	39,1
Hospital Admissions for COVID-19	6.607	82,8	13.160	90,6	1.634	92,7	21.401	88,2
Deaths from SARS due to COVID-19 in Admissions Hospital lethality (%)	2.729	34,2	4.637	31,9	542	30,7	7.908	32,6

Source: Own authorship, adapted from SIVEP-Gripe, 2022.

TABLE 2 - CASES, DEATHS AND LETHALITY DUE TO SERIOUS ACUTE RESPIRATORY SYNDROME DUE TO COVID-19 ACCORDING TO AGE, SEX, RACE/COLOR, MARANHÃO, BRAZIL, 2020-2022

Variables	2020				2021				2022				TOTAL - 2020 A 2022				Lethality
	Cases		Deaths		Cases		Deaths		Cases		Deaths		Cases		Deaths		
Age years)	N	DP	N	DP	N	DP	N	DP	N	DP	N	DP	N	DP	N	%	%
Average	61,0	19,6	68,3	16,3	56,9	18,3	64,1	16,5	60,5	25,6	67,8	21,6	58,3	-	65,9	16,9	-
median	64,0	-	71,0	-	57,0	-	66,0	-	68,0	-	73,0	-	60,0		68,0	-	
Sex	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	%
Feminine	3.292	41,3	1.376	38,0	6.163	42,4	2.217	41,9	855	48,5	253	43,0	10.310	42,5	3.846	40,5	37,3
Masculine	4.675	58,6	2.239	61,9	8.358	57,5	3.070	58,1	907	51,5	335	57,0	13.940	57,5	5.644	59,5	40,5
ignored	6	0,1	2	0,1	4	0,0	1	0,0	0	0,0	0	0,0	10	0,0	3	0,0	30,0
Race/Color	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	%
White	**964**	**12,1**	**525**	**14,5**	**1.748**	**12,0**	**796**	**15,1**	**229**	**13,0**	**82**	**13,9**	**2.941**	**12,1**	**1.403**	**14,8**	**47,7**
black	442	5,5	253	7,0	830	5,7	337	6,4	109	6,2	44	7,5	1.381	5,7	634	6,7	45,9
Yellow	340	4,3	81	2,2	436	3,0	98	1,9	16	0,9	6	1,0	792	3,3	185	1,9	23,4
brown	5.587	70,1	2.440	67,5	11.187	77,0	3.961	74,9	1.362	77,3	443	75,3	18.136	74,8	6.844	72,1	37,7
Indigenous	28	0,4	13	0,4	42	0,3	18	0,3	8	0,5	2	0,3	78	0,3	33	0,3	42,3
ignored	424	5,3	231	6,4	282	1,9	78	1,5	38	2,2	11	1,9	744	3,1	320	3,4	43,0
Uninformed	188	2,4	74	2,0	0	0,0	0	0,0	0	0,0	0	0,0	188	0,8	74	0,8	39,4
Total	7.973	100,0	3.617	100,0	14.525	100,0	5.288	100,0	1.762	100,0	588	100,0	24.260	100,0	9.493	100,0	39,1

Source: Own authorship, adapted from SIVEP-Gripe, 2022.

TABLE 3 – CASES, DEATHS AND LETHALITY DUE TO SERIOUS ACUTE RESPIRATORY SYNDROME DUE TO COVID-19 BY RISK FACTOR, HOSPITALIZATION IN AN INTENSIVE CARE UNIT AND USE OF VENTILATORY SUPPORT, MARANHÃO, BRAZIL, 2020-2022

Variables	2020				2021				2022				TOTAL - 2020 A 2022				Lethality
	Cases		Deaths		Cases		Deaths		Cases		Deaths		Cases		Deaths		
Risk factor	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	%
Yes	4.387	55,0	2.370	65,5	7.296	50,2	3.255	61,6	1.016	57,7	389	66,2	12.699	52,3	6.014	63,4	47,4
No	3.586	45,0	1.247	34,5	7.229	49,8	2.033	38,4	746	42,3	199	33,8	11.561	47,7	3.479	36,6	30,1
ICU	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	%
Yes	1.722	21,6	1.036	28,6	5.311	36,6	3.474	65,7	851	48,3	374	63,6	7.884	32,5	4.884	51,4	61,9
No	2.979	37,4	879	24,3	5.169	35,6	707	13,4	648	36,8	130	22,1	8.796	36,3	1.716	18,1	19,5
Ignored	616	7,7	295	8,2	426	2,9	281	5,3	31	1,8	11	1,9	1.073	4,4	587	6,2	54,7
Not informed	2.656	33,3	1.407	38,9	3.619	24,9	826	15,6	232	13,2	73	12,4	6.507	26,8	2.306	24,3	35,4
Ventilatory Support	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	%
Yes, invasive	898	11,3	675	18,7	2.636	18,1	2.059	38,9	362	20,5	255	43,4	3.896	16,1	2.989	31,5	76,7
Yes, non- invasive	1.617	20,3	533	14,7	5.551	38,2	1.133	21,4	464	26,3	125	21,3	7.632	31,5	1.791	18,9	23,5
No	1.477	18,5	482	13,3	1.806	12,4	213	4,0	521	29,6	69	11,7	3.804	15,7	764	8,0	20,1
Ignored	1.044	13,1	408	11,3	491	3,4	351	6,6	49	2,8	24	4,1	1.584	6,5	783	8,2	49,4
Not informed	2.937	36,8	1.519	42,0	4.041	27,8	1.532	29,0	366	20,8	115	19,6	7.344	30,3	3.166	33,4	43,1
Total	7.973	100,0	3.617	100,0	14.525	100,0	5.288	100,0	1.762	100,0	588	100,0	24.260	100,0	9.493	100,0	39,1

Source: Own authorship, adapted from SIVEP-Gripe, 2022.

Spatial analysis of SARS case fatality rate by COVID-19 by reporting municipality

In 2020, 25 municipalities (11.5%) recorded a fatality rate (FR) per notification municipality equal to 100%, while 136 (62.6%) municipalities did not register deaths. In 2021, five muni-

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cipalities (2.3%) presented LR per notification municipality equal to 100% (Amarante do Maranhão, Brejo, Lago Verde, Nova Colinas and Peritoró), while 158 (72.8%) municipalities had LR equal to zero. In 2022, six municipalities (2.7%) presented LR per notification municipality equals to 100%: Açailândia, Brejo, Coroatá, Estreito, Governador Newton Belo and Pedreiras. Another 182 (83.8%) municipalities did not register deaths (Figure 1).

In the period from 2020 to 2022, 106 municipalities (48.8%) did not notify cases in SIVEP-Gripe. There were no records of deaths in admissions/hospitalizations in 119 municipalities (54.8%). Eighteen municipalities (8.3%) presented LR per notification municipality equal to 100% (Figure 1).

Spatial analysis of the lethality rate due to SARS due to COVID-19 by municipality of residence

In 2020, twenty municipalities (9.2%) presented LR per municipality of residence equal to 100%; while 43 (19.8%) municipalities did not register deaths. In 2021, ten municipalities (54.6%) presented LR per municipality of residence equal to 100%; while seven (3.2%) municipalities had a LR equal to zero (Figure 2). In 2022, despite the drop in the total number of records (Table 1), 38 municipalities (17.5%) were observed with LR per municipality of residence equal to 100%. Another 99 (45.6%) municipalities did not register deaths (Figure 2).

No período de 2020 a 2022, cinco municípios (2,3%) apresentaram LR por município de residência igual a 100% (Bacurituba, Benedito Leite, Brejo de Areia, Satubinha e Tufilândia). Dois municípios (0,9%) não apresentaram registros de óbitos por município de residência: Afonso Cunha e Belágua (Figura 2).
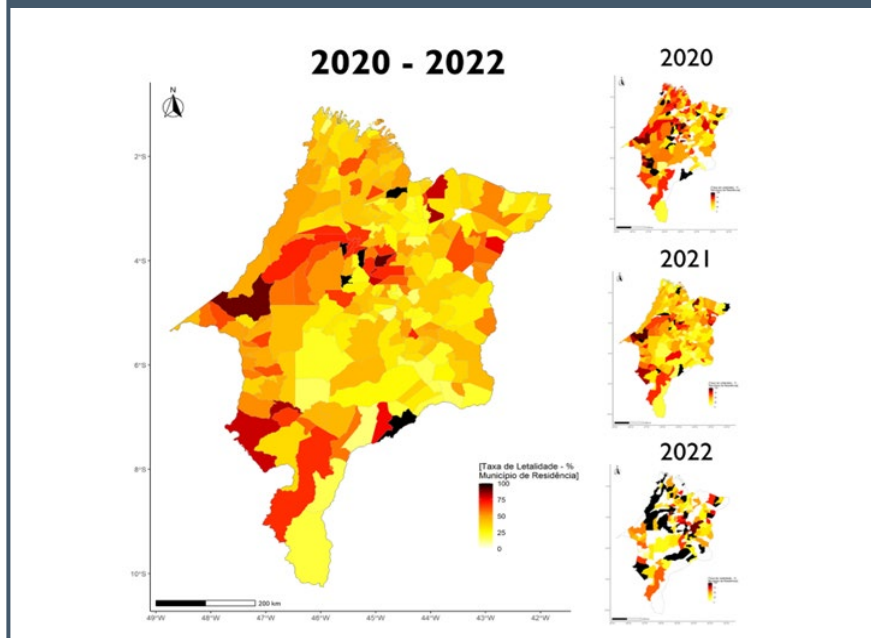
DISCUSSION

It was observed that most deaths

FIGURE 1 – LETHALITY RATE DUE TO SEVERE ACUTE RESPIRATORY SYNDROME DUE TO COVID-19 BY REPORTING MUNICIPALITY, MARANHÃO, BRAZIL, 2020-2022
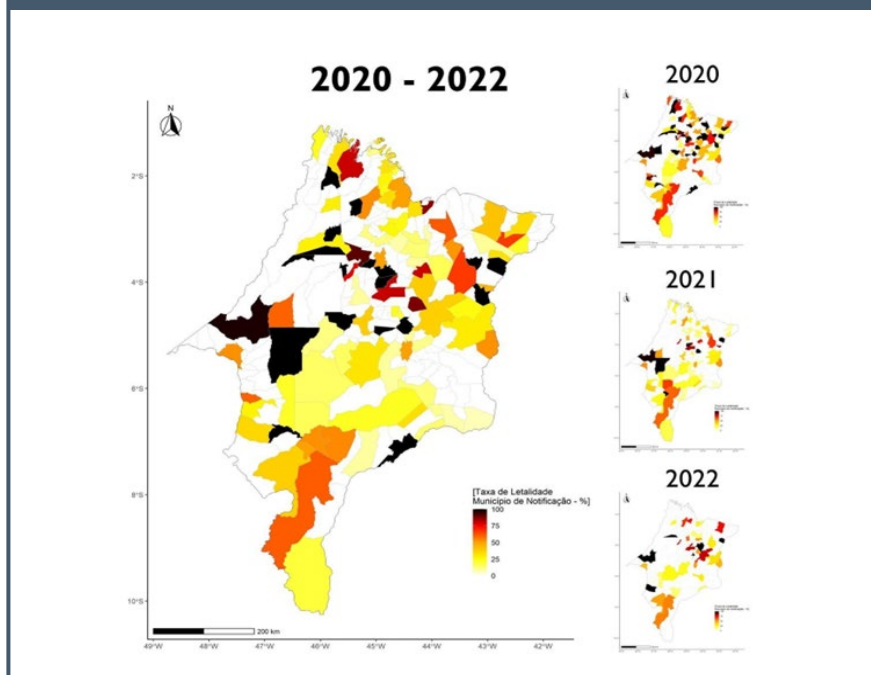
Source: Own authorship, adapted from SIVEP-Gripe, 2022.

FIGURE 2 - LETHALITY RATE DUE TO SERIOUS ACUTE RESPIRATORY SYNDROME DUE TO COVID-19 BY MUNICIPALITY OF RESIDENCE, MARANHÃO, BRAZIL, 2020-2022

Source: Own authorship, adapted from SIVEP-Gripe, 2022.

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were in males, with a mean age above 60 years and with comorbidities. Similar data were observed in the State of Piauí, also located in the northeast region of the country, and which presents social indicators similar to those of Maranhão. [10,11]

It was observed that most deaths were in males, with a mean age above 60 years and with comorbidities. Similar data were observed in the State of Piauí, also located in the northeast region of the country, and which presents social indicators similar to those of Maranhão. [18]

In Maranhão, when we analyze lethality by municipality of notification, we observe a higher frequency of records in more developed municipalities in the State and which are the headquarters of regional hospitals, have the largest hospital structure and receive most of the hospitalized patients, including field hospitals.

In this sense, it should be noted that the two municipalities with the highest absolute frequencies of deaths are the cities of São Luís, the capital, located in the north of the state, and Imperatriz, the second most populous municipality, located in the West region, close to the borders with the States of Tocantins and Pará, in the metropolitan region known as "Bico do Papagaio", representing a hospital center for the Midwest region of Maranhão. Other studies describe the influence of metropolitan regions on mortality rates, which would increase rates due to the greater supply of beds for hospitalization and, consequently, for notifications in municipalities with a larger hospital structure. [19]

Regarding the lethality rate according to the municipality of notification, it should be noted that 129 municipalities (59.4%) did not have death records, which can be explained by the shortage of beds, especially in the ICU, characterizing the lack of care . On the other hand, during the analyzed period, [18] municipalities had a lethality

rate of 100%. It is known that difficulties in accessing hospitalization, as well as the low quality of care, can increase mortality. [7,18,19] However, this lethality rate is probably related to underreporting and underreporting of deaths at home and cases, as well as reporting restricted exclusively to deaths [20], evidenced in some municipalities.

Another factor that suggests the existence of underreporting and underreporting of deaths from SARS due to COVID-19 is the excess of deaths from other causes that were observed throughout the country during the course of the pandemic. Excess deaths have been one of the most useful measures to assess the impact of COVID-19 on mortality, especially of other chronic diseases, in addition to reducing access to other health services in patients with comorbidities. [21,22,23]

Despite the high number of deaths recorded during the pandemic [7], it is likely that there is a high underreporting of deaths from SARS due to COVID-19, due to uncertainties and lack of structure for diagnosis, as well as the lack of experience of professionals in the first months of 2020. [21] It is also observed that most deaths from COVID-19 occurred in the elderly and patients with comorbidities, impairing the identification of the cause of death. Another factor that may have contributed to underreporting was the overload of the health network, as a death that occurred at home, outside the health services, would have greater difficulties in registering in the SIVEP-Gripe. [21]

Despite the mandatory notification of SARS, we can say that the notification rates in Brazil are low and that they do not correspond to the epidemiological reality of the country, corresponding to only 9.2% of the total cases of COVID-19, indicating that the real numbers for the epidemiological situation of cases and deaths are about ten times greater than those recorded in SIVEP-Gripe. [20]

Another factor that supports the underreporting/underreporting hypothesis is the high proportion of SARS records due to another etiologic agent or unspecified cause. These records did not show the final classification of SARS due to COVID-19, probably due to the lack of laboratory or imaging criteria, absent in several health units. In the present study, 11,063 (27.9%) notifications due to an unspecified cause or other etiological agent were observed, which were excluded in the methodological design and which could modify the lethality rates, if they were confirmed as SARS due to COVID-19.

It should be noted that there was no record of deaths from SARS due to COVID-19 in two municipalities per municipality of residence and in 119 municipalities per municipality of notification/hospitalization. In contrast, [18] municipalities were found with a lethality rate per municipality of notification/hospitalization and five municipalities with a lethality rate per municipality of residence equal to 100%, indicating that notifications in the SIVEP-Gripe were restricted exclusively to deaths. Finally, there is a need to improve the notification of SARS cases and deaths due to COVID-19 in SIVEP-Gripe in the State of Maranhão.

CONCLUSION

Municipalities with a lower development rate, with little or no hospital structure, had lower mortality rates. Additionally, differences were found between the lethality rates of the notification and residence municipalities. The data indicate the existence of underreporting and underreporting of cases and deaths in SIVEP-Gripe in Maranhão. Consequently, federal, state and municipal management measures are needed to improve the registration of notifications in SIVEP-Gripe.

artigo

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