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Influence of Covid-19 on the epidemiological profile of snakebites in Manaus, Brazilian Amazon: changes in human behavior ?

Influência da Covid-19 no perfil epidemiológico de acidentes ofídicos em Manaus, Amazônia Brasileira: mudanças no comportamento humano?

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ABSTRACT

Introduction: Snakebites and Covid-19 are two diseases that affected significantly the region of Manaus and the Amazonas state, but the impact of Covid-19 pandemic on the epidemiology of snakebites has been poorly studied. Objective: to evaluate the influence of the Covid-19 pandemic in the city of Manaus. Methodology: this study used cases reported in official databases to compare clinical and epidemiological aspects of snakebites before and during the pandemic in the study area. A total of 1,021 cases of snakebites were recorded. In general, there were no differences in geographic, seasonal, clinical and epidemiological aspects among the periods of study. Work-related cases increased significantly during the pandemic. Conclusions: Covid-19 did not have a direct influence on cases of snakebites in Manaus, but temporary migration to rural settlements likely influenced the number of snakebites related to work.

Keywords: Covid-19. Snakebite. Snake envenomations. Epidemiology. Pandemics.

RESUMO

Introdução: Acidentes ofídicos e Covid-19 são duas doenças que afetaram significativamente a região de Manaus e o Estado do Amazonas, mas o impacto da pandemia de Covid-19 na epidemiologia dos acidentes ofídicos tem sido pouco estudado. Objetivo: avaliar a influência da pandemia de Covid-19 na cidade de Manaus. Metodologia: este estudo usou casos notificados em bases de dados oficiais para comparar aspectos clínicos e epidemiológicos dos acidentes ofídicos antes e durante a pandemia na região de estudo. Resultados: um total de 1021 casos de ofidismo foram reportados. No geral, não houve diferenças em aspectos geográficos, clínicos e epidemiológicos entre os períodos de estudo. Casos relacionados ao trabalho aumentaram significativamente durante a pandemia. Conclusão: a Covid-19 não teve uma influência direta nos casos de ofidismo em Manaus, mas migração temporária para assentamentos rurais provavelmente influenciou o número de acidentes ofídicos relacionados ao trabalho.

Palavras-chave: Acidente ofídico. Covid-19. Epidemiologia. Envenenamento por serpentes. Pandemia.

1. INTRODUCTION

Snakebites continue to be a major neglected health issue, mainly in tropical areas. In Brazil, snakebites are mainly associated with people living in contact with snakes, such as adult men carrying out rural activities, indigenous and riverine people.[1] The country has four main genera of venomous snakes: the lanceheads (*Bothrops*), the rattlesnake (*Crotalus*), the bushmaster (*Lachesis*) and the coral snakes (*Micrurus*).[1]

Most of the snakebites in Brazil occur in its Amazon region.[2] The region has few roads, and most travel is along the rivers. Because of this, medical help can be hours or even days away.[1] In many cases, people often resort to traditional medicine, which further delays treatment.[1] Antivenom therapy is required in most cases[1] and lanceheads are responsible for over 80% of serious cases in the Brazilian Amazon.[2]

Snakebites in the Brazilian Amazon are influenced mainly by environmental and ecological aspects, such rainfall and forest cover;[3] however, it is possible that social crises can also influence the incidence of snakebites.[4] The emergence of the Coronavirus disease 2019 (Covid-19) triggered economic and social crises around the world. Covid-19 is a contagious disease caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and is transmitted mainly through air.[5] More than 676 million cases were reported worldwide, with over 6.8 million deaths.[6] The possible negative impact of Covid-19 on snakebites spans from budget cuts and shortage of equipment and professionals to less people seeking hospitals for fear of the Covid-19 and transport difficulties, as well as shortage of antivenoms.[7]

Before the vaccines were available, lockdown was used to stop the transmission of the disease,[8] but due economic and political pressure, in many cases these measures were not respected.[9] The state of Amazonas and its capital city Manaus, in the northern region of Brazil, was particularly hit hard by the successive waves of Covid-19.[10] However, the influence of the pandemic on envenomations by venomous animals and their treatment in the area is still unknown. The state of Amazonas is located in the Amazon region of Brazil and has the highest incidence of snakebites;[2] therefore, it potentially serves as a model to test the influence of the Covid-19 pandemic on snakebites. As such this study aims to evaluate the influence of the Covid-19 pandemic on snakebites in the city of Manaus.

2. MATERIALS AND METHODS

Data was gathered from the *Sistema de Informação de Agravos de Notificação* (SINAN) regarding snakebites treated at the Fundação de Medicina Tropical Doutor Heitor Vieira Dourado (FMT-HVD), in Manaus. Cases from other municipalities were considered since victims of snakebites from the countryside are also treated at FMT-HVD. The cases occurred in the period from January 2018 to October 2021. The years of 2018 and 2019 were considered the pre-pandemic period, and the years of 2020 and 2021 were the defined as the pandemic period. Sociodemographic, clinical and epidemiological aspects were analyzed in order to evaluate how these parameters were influenced by the Covid-19 pandemic. To verify the number of cases treated at FMT-HVD before and during the pandemic, the dichotomous variable “group” was created, considering “0” the years 2018-2019 and “1” 2020-2021. Using the results, a table was generated according to the demographic variables, using the cases treated at FMT-HVD.

This study was approved by the Ethics Committee of the Universidade do Estado do Amazonas (approval number 52805821.4.0000.5016).

3. RESULTS

During the period studied, 1,021 cases of snakebite were treated at the hospital; 194 in 2018, 276 in 2019, 270 in 2020 and 281 in 2021. Geographic and temporal variations in incidence were not observed in the years before and during the pandemic (Figure 1). During the pandemic, the seasonality of snakebites was concentrated in the first months of the year**,** which is the period of the heaviest rains (Figure 2). Detailed data for each of the clinical, epidemiological and sociodemographic parameters are given in Table 1. Only three deaths as a result of a snakebite were reported. Most of the cases in both periods occurred in rural areas (87%), and the most affected group were of mestizo race (91%), males (79%), who were bitten in the lower limbs (88.3%) and most bites were caused by lanceheads (*Bothrops*) (91%). The mean age of the victims was 30 years old and the age of those most affected was between 11 and 40 years old. No statistical difference ($p > 0.05$) among the periods of study was found in the data regarding the sex and the age of the patients, nor for time to medical care, severity, local manifestations, systemic complications, use of antivenom and outcome of cases. However, differences ($p < 0.05$) were found in systemic

manifestations, local complications, race, type of snake, work-related cases and in the use of antivenom against *Bothrops* bites.

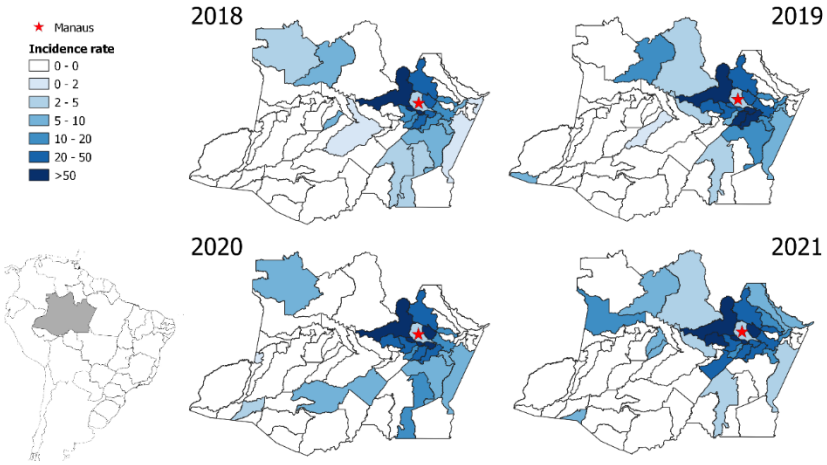

Figure 1: Distribution of observed incidence of snakebites per 100,000 inhabitants in Amazonas state based on the patients treated at FMT-HVD, in Manaus, in the years before (2018/2019) and during (2020/2021) the Covid-19 pandemic.

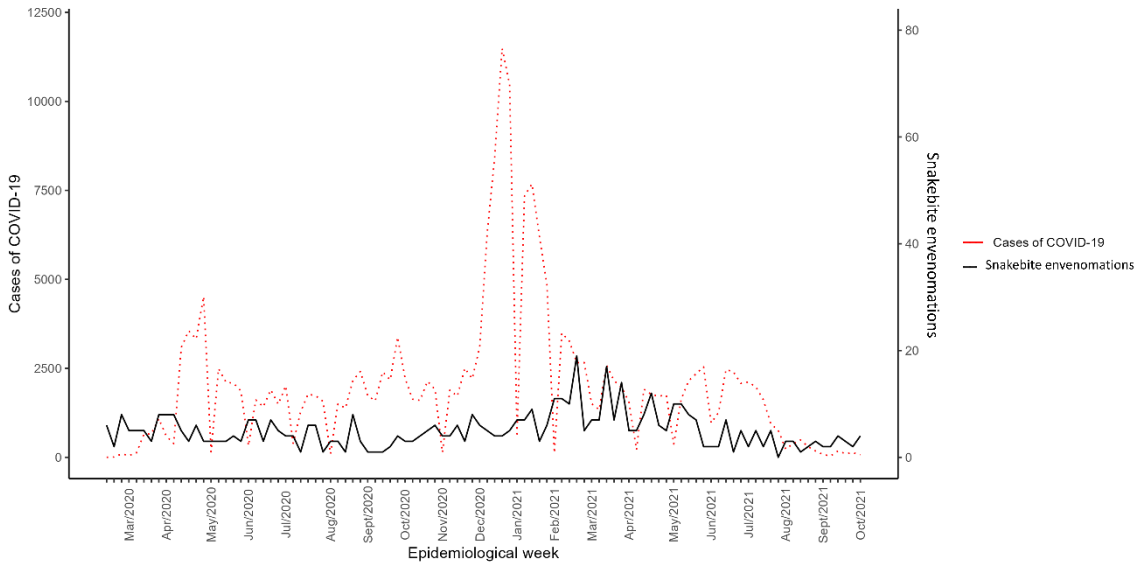

Figure 2: Weekly distribution of cases of snakebite (continuous black lines) and Covid-19 (dashed red lines) in the city of Manaus, Amazonas state, spanning from January 2020 to October 2021.

Table 1: Descriptive table of clinical and epidemiological data on snakebites treated in Fundação de Medicina Tropical Doutor Heitor Vieira Dourado, in Manaus.

Characteristic	**Overall, N = 937[1]**	**(2018-2019), N = 433[1]**	**(2020-2021), N = 504[1]**	**p-value[2]**
Sex				0.9
Female	197 (21%)	92 (21%)	105 (21%)	
Male	740 (79%)	341 (79%)	399 (79%)	
Race				**0.002**
White	11 (1.2%)	2 (0.5%)	9 (1.8%)	
African	8 (0.9%)	3 (0.7%)	5 (1.0%)	
Asian	2 (0.2%)	2 (0.5%)	0 (0%)	
Mixed	839 (91%)	404 (94%)	435 (88%)	
Indigenous	66 (7.1%)	19 (4.4%)	47 (9.5%)	
Age	31 (19, 46)	30 (19, 46)	32 (19, 46)	0.5
Age group				0.7
0-10	81 (8.6%)	40 (9.2%)	41 (8.1%)	
11-20	185 (20%)	90 (21%)	95 (19%)	
21-30	193 (21%)	91 (21%)	102 (20%)	
31-40	163 (17%)	73 (17%)	90 (18%)	
41-50	132 (14%)	52 (12%)	80 (16%)	
51-60	92 (9.8%)	43 (9.9%)	49 (9.7%)	
>60	91 (9.7%)	44 (10%)	47 (9.3%)	
Education level				
1st to 4th incomplete grades of primary school	44 (6.3%)	21 (9.0%)	23 (4.9%)	
4th complete series of primary school	48 (6.8%)	26 (11%)	22 (4.7%)	
5th to 8th grade incomplete of middle school	436 (62%)	132 (57%)	304 (65%)	

Complete elementary school	30 (4.3%)	17 (7.3%)	13 (2.8%)	
Complete secondary school	64 (9.1%)	15 (6.4%)	49 (10%)	
Incomplete secondary school	55 (7.8%)	15 (6.4%)	40 (8.5%)	
Complete higher education	7 (1.0%)	2 (0.9%)	5 (1.1%)	
Incomplete higher education	5 (0.7%)	3 (1.3%)	2 (0.4%)	
Illiterate	14 (2.0%)	2 (0.9%)	12 (2.6%)	
Pregnancy				0.6
1st Quarter	1 (0.1%)	0 (0%)	1 (0.2%)	
2nd Quarter	5 (0.5%)	2 (0.5%)	3 (0.6%)	
3nd Quarter	1 (0.1%)	0 (0%)	1 (0.2%)	
Gestational age unknown	2 (0.2%)	2 (0.5%)	0 (0%)	
No	133 (14%)	58 (13%)	75 (15%)	
Not applicable	795 (85%)	371 (86%)	424 (84%)	
Zone of occurrence				0.2
Urban	88 (9.4%)	48 (11%)	40 (8.0%)	
Rural	813 (87%)	367 (85%)	446 (89%)	
Periurban	34 (3.6%)	17 (3.9%)	17 (3.4%)	
Type of snake				**<0.001**
Bothrops (lancehead)	853 (91%)	419 (97%)	434 (86%)	
Crotalus (rattlesnake)	2 (0.2%)	0 (0%)	2 (0.4%)	
Micrurus (coral snake)	1 (0.1%)	1 (0.2%)	0 (0%)	
Lachesis (bushmaster)	75 (8.0%)	10 (2.3%)	65 (13%)	
Non-Venomous snake	4 (0.4%)	2 (0.5%)	2 (0.4%)	
Bite site				
Arm	4 (0.4%)	1 (0.2%)	3 (0.6%)	
Finger	27 (2.9%)	11 (2.5%)	16 (3.2%)	

Foot	535 (57%)	248 (57%)	287 (57%)	
Forearm	7 (0.7%)	4 (0.9%)	3 (0.6%)	
Hand	69 (7.4%)	31 (7.2%)	38 (7.5%)	
Head	2 (0.2%)	2 (0.5%)	0 (0%)	
Leg	225 (24%)	109 (25%)	116 (23%)	
Thigh	10 (1.1%)	4 (0.9%)	6 (1.2%)	
Toe	58 (6.2%)	23 (5.3%)	35 (6.9%)	
Time to medical care				0.2
0 to 1 h	57 (6.1%)	31 (7.2%)	26 (5.3%)	
1 to 3 h	223 (24%)	108 (25%)	115 (23%)	
3 to 6 h	289 (31%)	134 (31%)	155 (31%)	
6 to 12 h	130 (14%)	56 (13%)	74 (15%)	
12 to 24 h	112 (12%)	43 (9.9%)	69 (14%)	
>24 h	117 (13%)	61 (14%)	56 (11%)	
Work-related case	447 (49%)	178 (41%)	269 (55%)	**<0.001**
Use of antivenom	926 (99%)	425 (99%)	501 (99%)	0.5
Antivenom for *Bothrops*				**<0.001**
1-3	34 (4.4%)	2 (0.6%)	32 (7.5%)	
4-6	292 (38%)	128 (38%)	164 (38%)	
7-10	329 (43%)	163 (48%)	166 (39%)	
>10	111 (14%)	44 (13%)	67 (16%)	
Antivenom for *Bothrops*/*Lachesis*				**0.023**
1-3	10 (5.5%)	6 (6.1%)	4 (4.9%)	
4-6	41 (23%)	14 (14%)	27 (33%)	
7-10	69 (38%)	40 (40%)	29 (35%)	
>10	61 (34%)	39 (39%)	22 (27%)	

Antivenom for *Micrurus*				
7-10	1 (100%)	1 (100%)	0 (NA%)	
Antivenom for *Bothrops*/Crotalus				>0.9
1-3	4 (31%)	0 (NA%)	4 (31%)	
4-6	8 (62%)	0 (NA%)	8 (62%)	
>10	1 (7.7%)	0 (NA%)	1 (7.7%)	
Clotting time				0.5
Normal	401 (44%)	189 (45%)	212 (43%)	
Altered	506 (56%)	227 (55%)	279 (57%)	
Local manifestations	934 (100%)	431 (100%)	503 (100%)	0.6
Ecchymosis	317 (34%)	139 (32%)	178 (35%)	0.3
Necrosis	127 (26%)	60 (25%)	67 (27%)	0.5
Local manifestations - necrosis	33 (3.5%)	16 (3.7%)	17 (3.4%)	0.8
Local complications	376 (41%)	111 (26%)	265 (54%)	**<0.001**
Local complications - local	24 (2.6%)	16 (3.8%)	8 (1.6%)	**0.035**
Local complications - Functional deficit	1 (0.3%)	1 (0.9%)	0 (0%)	0.3
Local complications - shock	934 (100%)	431 (100%)	503 (100%)	>0.9
Local complications - Intense necrosis	5 (1.3%)	4 (3.6%)	1 (0.4%)	**0.028**
Local complications - Compartment syndrome				**0.001**
Yes	8 (2.1%)	7 (6.3%)	1 (0.4%)	
No	368 (98%)	104 (94%)	264 (100%)	
Systemic complications	28 (3.1%)	16 (3.8%)	12 (2.4%)	0.2
Oliguria/anuria	43 (8.8%)	22 (9.0%)	21 (8.5%)	0.9
Systemic manifestations - vomits	215 (44%)	120 (49%)	95 (39%)	**0.023**
Systemic manifestations - others	267 (55%)	112 (47%)	155 (63%)	**<0.001**
Systemic complications - shock	1 (3.6%)	1 (6.3%)	0 (0%)	>0.9

Systemic complications - kidney failure	25 (89%)	14 (88%)	11 (92%)	>0.9
Amputation	0 (0%)	0 (0%)	0 (0%)	>0.9
Septicemia	2 (7.1%)	2 (13%)	0 (0%)	0.5
Outcome				>0.9
Cure	916 (100%)	431 (100%)	485 (100%)	
Death from accidents by venomous animals	3 (0.3%)	1 (0.2%)	2 (0.4%)	

4. DISCUSSION

In general, the cases showed no spatial differences among the years studied. The highest incidence rates were concentrated in municipalities near Manaus, due to these municipalities having access to the capital by road, which means that these patients can reach FMT-HVD in no more than a few hours.[11] Although some municipalities far from Manaus showed a medium incidence level in some years, this is based on isolated cases that were likely more severe, and which were transported to Manaus or patients transported to Manaus when antivenom was unavailable in the countryside.[11] In early 2020, during the health emergency caused by Covid-19, the state government suspended transport between municipalities, but this measure did not affect emergency transport, such as those related to victims of snakebites needing to be treated in Manaus.[12] Snakebites in the Amazon are more common during the rainy season.[1] Our seasonal data shows that the peak of snakebites in Manaus occurred in this same period (in the first months of the year), and were not influenced by the peaks of the two waves of Covid-19 in the city (early 2020 and late 2020/early 2021).

Snakebites in the Brazilian Amazon, as in other regions in Brazil, are more likely to occur in mestizo men of a working age, who work in agricultural and forestry activities such as fishing, hunting and harvesting.[1] Work-related cases showed a significant increase during the pandemic, possibly due a greater number of people migrating to rural or peripheral zones, a movement that has been observed in Amazonas state during the pandemic. As mentioned above, these people could not afford to stop working during the pandemic, and rural work is considered a risk factor for envenomation by venomous animals.[1] In other regions, this migration was associated with a higher risk of snakebites.[7] However, most of the aspects related to epidemiology, manifestations and treatment did not differ between the

periods. It has been suggested elsewhere that differences in systemic manifestations and local complications could be related to delays in reaching the hospital because of the pandemic,[13] but since there was no difference in the time taken to reach medical care, we think that our data does not explain those differences. Differences in type of snake and in the use of antivenom can be explained because there was an increase in cases supposedly caused by *Lachesis*. However, we believe that confusion occurred due the similar popular names and clinical manifestations that *Bothrops* and *Lachesis* share.[1]

Snakebites can be more serious than envenomations by other animals such as spiders and scorpions and evolve to severe cases, although the death rate is low in Brazil,[2] and despite the fact that patients may have delayed seeking medical care until more serious symptoms appear because of fear of Covid-19, they know that snakebites can be dangerous and need to be treated at a hospital.[11] Our data do not show differences in incidence in the pre-pandemic and pandemic periods, which is probably because people sought medical assistance regardless of the health emergency situation. Poverty in Brazil has risen in the last years, likely due the economic problems as a result of the pandemic, and snakebites hare associated with poverty.[7,14] As pointed out above, lockdown measures were not followed, in part because people depending on subsistence activities (like agriculture) did not stop working during the quarantine and continued to be exposed to snakebites.[8] This is also true for many rural communities in other parts of the world; the level of exposure to snakebites did not change with the pandemic.[7] The influence of the pandemic in other regions includes limitations to the access of snakebite treatment in areas of quarantine[13] and increasing costs of antivenom in low-income áreas,[15] although we found no direct association between Covid-19 and snakebites in Manaus.

5. FINAL CONSIDERATIONS

In general, our data show that the geographical, seasonal, epidemiological and clinical profile of snakebites treated at FMT-HVD did not change with the pandemic, but the rise in work-related cases indicates that the exit from urban centers, changes in work activity and migration to rural areas likely play a role in this particular aspect. This is likely because due socioeconomic characteristics, during the pandemic people continued to be exposed to snakebites.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

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