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BRIEF COMMUNICATION / *COMUNICAÇÃO BREVE*

Spatial analysis of the origin-destination flow of admissions for severe acute respiratory syndrome caused by COVID-19 in the Metropolitan Region of Rio de Janeiro

Análise espacial do fluxo origem-destino das internações por síndrome respiratória aguda grave por COVID-19 na região metropolitana do Rio de Janeiro

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ABSTRACT: This study analyzed the inter-municipality flow of hospital admissions due to severe acute respiratory syndrome by COVID-19 in the metropolitan region of Rio de Janeiro. We identified 12,676 inter-municipality hospitalizations for COVID-19 involving the municipality of Rio de Janeiro. In total, 11,288 (89.0%) admissions were of residents of the Metropolitan Region (RM), 87% residents in other municipalities of the same region and admitted to hospitals from the state capital, and 13% residents of the capital admitted to hospitals from other municipalities in the RM. There was a negative correlation when it comes to the distance between cities and the origin-destination flow ($r=0.62$, $p<0.001$). The RM of the capital Rio de Janeiro imports more admissions for SARS by COVID-19 than it exports. This study highlights the importance of care networks intended for more severe cases that mainly require specialized care.

Keywords: COVID-19. Spatial analysis. Health management. Coronavirus infections.

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RESUMO: Este estudo analisou o fluxo intermunicipal das internações por síndrome respiratória aguda grave por COVID-19 na região metropolitana do Rio de Janeiro. Foram identificadas 12.676 internações intermunicipais por COVID-19 envolvendo o município do Rio de Janeiro. Dessas, 11.288 (89,0%) eram de residentes na região metropolitana, 87% de residentes em outros municípios da mesma região e internados na capital do estado, e 13% eram residentes da capital internados em outros municípios da região. Há correlação negativa entre a distância dos municípios e o fluxo origem-destino (r=0,62, p<0,001). O município do Rio de Janeiro importa mais internações por síndrome respiratória aguda grave por COVID-19 do que exporta. Este estudo evidenciou a importância das redes de atendimento para casos mais graves, os quais necessitem, principalmente, de atenção especializada.

Palavras-chave: COVID-19. Análise espacial. Gestão em saúde. Infecções por coronavírus.

INTRODUCTION

COVID-19 was declared a public health emergency of international concern (PHEIC) on January 30 and a pandemic on March 11, 2020. As of July 10, 2021, there were 19 million cases and 530,000 deaths in Brazil. The municipality of Rio de Janeiro (MRJ) reported more than 390,000 confirmed cases and 29,000 deaths in this period[1].

COVID-19 caused a collapse in the Brazilian health system from March to May 2021 as a result of the occupation of beds in intensive care centers and intensive care units (ICU). In the municipality of Rio de Janeiro, in addition to the collapse resulting from the lack of beds, there was a lack of supplies such as intubation kits[2,3]. The Brazilian hospital network is poorly distributed geographically. Some strategies such as bed regulation seek to partially solve this issue. However, part of this flow is spontaneous, especially in the private service. COVID-19 caused a retraction in the supply of beds due to an explosion in demand, especially intensive care beds, which makes this discussion urgent for the public and private health services network[4].

As in other health regions, the metropolitan region (MR) of the city of Rio de Janeiro comprises a large part of these medium and high complexity beds. Therefore, the aim of this study was to analyze the flow of hospitalizations for SARS by COVID-19 between cities in the MR of Rio de Janeiro.

METHODS

We carried out an ecological study of secondary data, whose units of analysis were the cities of the metropolitan region and Rio de Janeiro. The MR aggregates 22 of the 92 municipalities in the state of Rio de Janeiro: Belford Roxo, Cachoeiras de Macacu, Duque de Caxias, Guapimirim, Itaboraí, Itaguaí, Japeri, Magé, Maricá, Mesquita, Nilópolis, Niterói, Nova Iguaçu, Paracambi, Petrópolis, Queimados, Rio Bonito, São Gonçalo, São João de Meriti, Seropédica, Tanguá and the municipality of Rio de Janeiro.

The data used for the analyses were the admissions of patients with SARS due to COVID-19 of the Influenza Epidemiological Surveillance Information System (Sivep-Influenza). The inclusion criteria were hospitalizations of SARS with notification dates from March 23, 2020 (date of the hundredth case registered in the state of Rio de Janeiro) to July 10, 2021 (end of epidemiological week 27), with final classification of COVID-19, whose origin-destination flow of hospitalization has been from the state of Rio de Janeiro and the metropolitan region to the municipality of Rio de Janeiro, or vice versa. We used the variables municipality of residence as origin and municipality of notification as destination. Then we elaborated flow maps and created an origin-destination matrix representing the difference between the "import" and the "export" of cases in the MRJ.

The analyses were performed using the R 3.6.1 software and thematic maps were created using the QGIS 3.14 software. To prepare the flow maps, we used the packages Oursins and AequilibraE from QGIS, as well as the Openroute Service plugin to capture the distances and travel time from the cities of origin to Rio de Janeiro. As this is an analysis of secondary data and without individual identification, this study is exempted from consideration by the Research Ethics Committee.

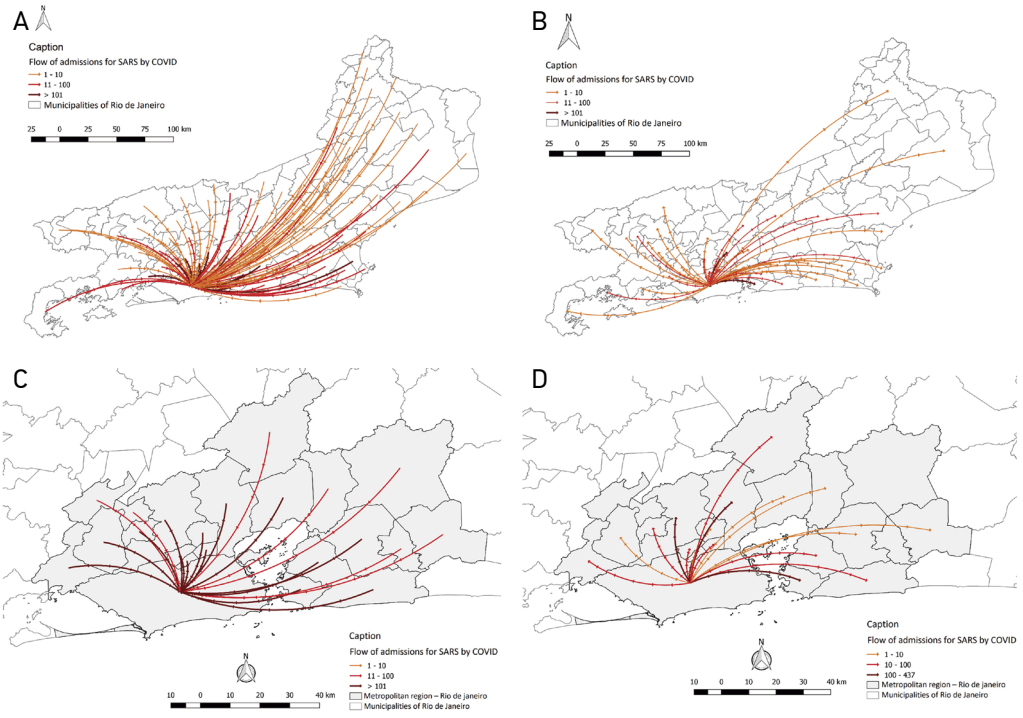
RESULTS

In total, 14.7% of hospitalizations in the state capital were cases from outside the city of Rio de Janeiro. A total of 12,676 inter-municipal hospitalizations for COVID-19 were identified involving the municipality of Rio de Janeiro, with 11,017 (86.9%) residents from other parts of the state and hospitalized in MRJ (Figure 1A) and 1,659 (13.1%) residents in the city of Rio de Janeiro and hospitalized in other cities of the MR (Figure 1B). Among these hospitalizations, 11,288 (89.0%) were of patients residing in the MR, 9,825 (87%) from municipalities in the MR and hospitalized in the MRJ (Figure 1C) and 1,463 (13%) residing in the MRJ and hospitalized in other cities in the MR (Figure 1D).

There is a negative correlation of the distance between municipalities and the origin-destination flow ($r=0.62$, $p<0.001$). Municipalities that are less than 40 kilometers and less than an hour of travel distant were related with the greatest volume of the migratory balance, except for Niterói. In the end, the balance between origin and destination is positive. This means that the capital "imports" many more cases of hospitalization than it "exports". Niterói was the only municipality in the metropolitan region with a negative balance, that is, it received more citizens from the state capital than it sent from Niteroi (Table 1).

DISCUSSION

Fighting the COVID-19 pandemic in the state has been challenging due to the heterogeneous profile of the population, divided into municipalities with equally different demographic, economic and social dimensions[5]. The challenge for the management of public



Source: Influenza Epidemiological Surveillance Information System (SIVEP-Influenza), 2021.

Figure 1. Flow of admissions for SARS by COVID-19, according to origin-destination for the state of Rio de Janeiro, considering "import" (A) and "export" of cases (B); and for the metropolitan region, considering "import" (C) and "export" of cases (D) – 2020 and 2021.

Table 1. Matrix of origin-destination of hospitalization for cases of severe acute respiratory syndrome due to COVID-19 between the municipality of Rio de Janeiro and municipalities in the metropolitan region – 2020 and 2021 (n = 11,288).

MRJ	Municipality 2	Import		Export		B	T(h)	D (km)
		n	%	n	%			
MRJ	Belford Roxo	884	9.0	3	0.2	881	0.48	31.43
MRJ	Cachoeiras de Macacu	26	0.3	0	0.0	26	1.57	100.42
MRJ	Duque de Caxias	1,794	18.3	417	28.5	1,377	0.37	21.14
MRJ	Guapimirim	27	0.3	1	0.1	26	0.97	74.65
MRJ	Itaboraí	135	1.4	3	0.2	132	0.77	49.58
MRJ	Itaguaí	264	2.7	72	4.9	192	0.93	68.96
MRJ	Japeri	99	1.0	0	0.0	99	0.99	78.05
MRJ	Magé	306	3.1	5	0.3	301	0.79	59.84

Continue...

Table 1. Continuation.

MRJ	Municipality 2	Import		Export		B	T(h)	D (km)
		n	%	n	%			
MRJ	Maricá	103	1.0	26	1.8	77	0.88	58.69
MRJ	Mesquita	586	6.0	15	1.0	571	0.48	32.61
MRJ	Nilópolis	711	7.2	131	9.0	580	0.53	33.46
MRJ	Niterói	376	3.8	437	29.9	-61	0.49	22.04
MRJ	Nova Iguaçu	2,091	21.3	111	7.6	1,980	0.59	37.71
MRJ	Paracambi	37	0.4	0	0.0	37	1.06	80.59
MRJ	Petrópolis	52	0.5	38	2.6	14	0.91	64.87
MRJ	Queimados	273	2.8	28	1.9	245	0.68	49.56
MRJ	Rio Bonito	24	0.2	2	0.1	22	1.02	78.39
MRJ	São Gonçalo	557	5.7	82	5.6	475	0.52	28.26
MRJ	São João de Meriti	1,332	13.6	82	5.6	1,250	0.43	25.73
MRJ	Seropédica	134	1.4	10	0.7	124	0.83	65.61
MRJ	Tanguá	14	0.1	0	0.0	14	0.89	65.71
	Total	9,825	100	1,463	100	8,362		

MRJ: municipality of Rio de Janeiro; B: balance; T (h): travel time in hours; D (km): distance in kilometers.
Source: Influenza Epidemiological Surveillance Information System (SIVEP-Influenza), 2021.

health in the state has been even greater due to the underfunding of the Unified Health System (SUS) over the past few years[6]. Therefore, understanding the origin-destination flow of hospitalizations for SARS by COVID-19 helps in the development of public policies that can meet the real needs of the population.

The results show important import and export patterns of severe cases of COVID-19. It is important to mention that this flow varied in the period studied. The collapse experienced in Brazil between the end of 2020 and April 2021, with ICU occupancy rates close to 100% in all states[7], changed the dynamics of assistance flows. For the metropolitan region object of this study, the city of Rio de Janeiro was not the only attraction pole in this period due to the increased demand for beds, but it maintained a central role in extra-municipal care even with a high saturation in the network[8]. In a hypothetical new worsening of this crisis, this situation may reoccur.

CONCLUSIONS

Measures must be adopted not only by the city of Rio de Janeiro, but by the entire metropolitan region, where many economic activities converge, including trade routes, thus

creating an intense commuting movement in this region. We can then say that the isolated effort of the municipality of Rio de Janeiro may not result in the expected effects in reducing bed occupancy rates or the circulation of the virus.

The uniformity of non-pharmacological measures (especially related to the restriction of circulation) and vaccination schedules should be considered within the logic of health care networks, rather than political and administrative limits—especially municipal ones. Therefore, the pandemic must be managed in a regionalized and agreed-upon manner.

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