DOI: 10.1590/1413-81232020259.23642020

Excess mortality in Brazil in times of Covid-19

Gulnar Azevedo e Silva (http://orcid.org/0000-0001-8734-2799) [1]
Beatriz Cordeiro Jardim (http://orcid.org/0000-0002-3075-2591) [1]
Cleber Vinicius Brito dos Santos (http://orcid.org/0000-0001-5710-2866) [1]

Abstract *Given the growing number of deaths due to the COVID-19 pandemic in Brazil, this study presents an initial and exploratory descriptive analysis of the excess mortality observed from March to May 2020 in capitals and other municipalities. The data source was the death registers from the Civil Registry Offices. The data were disaggregated by gender and capitals and other municipalities of the 26 federative units and the Federal District. The standardized mortality ratio for 2020 was calculated with the 2019 mortality coefficients as standards. The results showed 39,146 excess deaths for the period studied and is higher among men. This increase was more significant among the capitals of the North, Northeast, and Southeast regions. In the other municipalities in these regions, the increase was observed in May, indicating a possible inland-bound COVID-19 transmission. The need to improve the detection and registration of cases is highlighted to enable the efficient monitoring of the pandemic.*

Key words *Excess mortality, COVID-19, Information systems*

[1] Instituto de Medicina Social, Universidade do Estado do Rio de Janeiro. R. São Francisco Xavier 524/7º/Bl. D e E, Maracanã. 20550-900 Rio de Janeiro RJ Brasil. gulnar@ims.uerj.br

Introduction

The COVID-19 pandemic is so far the most significant health challenge of this century, causing more than 9 million cases and 470,000 deaths worldwide (June 22)[1]. The disease was first described in China in late 2019 and quickly spread worldwide[2]. Since then, many efforts have been made in several countries to control the epidemic, but global growth continues[3].

In Brazil, the first case of COVID-19 was recorded on February 26[4]. Since then, more than one million cases and 50,000 deaths have been reported, placing Brazil as the country with the second-highest number of cases and deaths in the world[1,5]. However, the number of reported cases and deaths is highly dependent on the testing policy adopted. Some countries only test patients in need of hospitalization, others recommend testing all those with symptoms, regardless of the need for hospital care, and some countries still implement mass testing.

In Brazil, in particular, the outlook for mitigating the epidemic is not favorable due to unfavorable political scenarios and the lack of national planning integrated with states and municipalities. Considering that a significant number of cases of the disease develop unfavorably, understanding the burden of COVID-19 in the country's mortality profile should be among the priorities in facing the various epidemics since the first suspected case of the disease was recorded. The use of data from existing information systems in Brazil can provide a good benchmark to monitor the epidemic, define prevention and control measures and assess the impact on the weight that this new disease has caused in the country's morbimortality.

This study aimed to describe in an exploratory way the relationship between deaths observed in the months in which the COVID-19 epidemic arrived in Brazil so far, compared with the number of expected deaths concerning 2019 by capital and inland in the federative units and the Federal District by gender.

Methods

The data source for this study was the registry of deaths from natural causes informed by the Civil Registry of Natural Persons and made available by the National Association of Natural Persons Registrars (ARPEN) on its freely accessible website[6]. The information on this website is updated daily with the sending of the data registered by the notary offices at the Civil Registry Information Center (CRC). Considering the legal deadlines for sending information[7], the set of deaths between March 1 to May 31, 2019 and 2020 was considered, with data obtained on June 30, 2020. Municipal population projections by gender and age range calculated by Freire et al.[8] were employed.

The number of deaths from all the natural causes was analyzed monthly, broken down by capitals and other municipalities in the 26 federative units and the Federal District by gender. The standardized mortality ratio (SMR) for 10-year age groups for 2020 was calculated using the mortality coefficients of the corresponding months and locations in 2019 as standards. The 95% confidence intervals for each SMR were calculated assuming a Poisson distribution, as described by Breslow and Day[9].

The number of excess deaths was calculated as the difference between the number of deaths observed and the number of expected deaths, from the mortality coefficients in the same months of 2019, applied to the population projected for 2020 in the respective locations. The negative monthly values were defined as zero for the calculation of the total by location. States with extreme values for SMR were excluded by visual inspection for the graphical representation of the data. The analyses were performed using STATA/MP version 14.2[10].

Results

Tables 1 and 2 show the standardized mortality ratios and the excess deaths calculated for March through May 2020 in the Federal District, in the capitals and other municipalities of the Brazilian federative units, in men and women, respectively. A total of 39,146 excess deaths were estimated in Brazil for this period, of which 23,979 were men and 15,167 women. For the capitals, excess of deaths totaled 27,069, while 12,077 were recorded for the other municipalities.

The most significant excess deaths were observed in capitals of the North Region: Manaus (AM), Belém (PA); Northeast Region: Fortaleza (CE) and Recife (PE), and Southeast Region: Rio de Janeiro (RJ) and São Paulo (SP), for both genders, and were higher among men. For the other municipalities, the most significant excess deaths were observed in the Northeast (PE) and Southeast (RJ and SP) regions (Tables 1 and 2). Some

Table 1. Standardized Mortality Ratios (SMR) and number of excess deaths among men from capitals and inland municipalities of the federal units and Federal District, Brazil, March to May 2020.

Region	State	Location	March		April		May		Excess deaths
			Ratio O/E	95% CI	Ratio O/E	95% CI	Ratio O/E	95% CI	
North	AC	Capital	1.03	(0.84 -1.24)	1.30	(1.06 -1.57)	2.10	(1.81 -2.41)	131
		Inland	0.96	(0.76 -1.20)	0.90	(0.71 -1.13)	0.75	(0.58 -0.96)	0
	AM	Capital	1.01	(0.93 -1.10)	3.29	(3.14 -3.44)	2.39	(2.26 -2.53)	2,016
		Inland	1.10	(0.87 -1.37)	1.53	(1.27 -1.82)	2.51	(2.16 -2.88)	167
	AP	Capital	0.41	(0.30 -0.55)	0.71	(0.56 -0.89)	1.62	(1.39 -1.88)	67
		Inland	0.48	(0.27 -0.80)	1.20	(0.86 -1.63)	2.79	(2.22 -3.46)	59
	PA	Capital	1.07	(0.98 -1.16)	2.72	(2.57 -2.88)	2.82	(2.66 -2.97)	1,626
		Inland	0.85	(0.79 -0.92)	0.99	(0.92 -1.07)	1.47	(1.39 -1.56)	362
	RO	Capital	26.11	(21.89 -30.9)	1.10	(0.91 -1.32)	3.05	(2.75 -3.37)	394
		Inland	1.08	(0.95 -1.22)	0.77	(0.67 -0.87)	0.91	(0.80 -1.03)	17
	RR	Capital	1.01	(0.82 -1.23)	0.82	(0.66 -1.01)	1.63	(1.39 -1.90)	66
		Inland	0.95	(0.43 -1.79)	1.40	(0.52 -3.06)	1.18	(0.67 -1.91)	4
	TO	Capital	0.63	(0.46 -0.85)	0.72	(0.53 -0.96)	0.81	(0.61 -1.06)	0
		Inland	1.22	(1.04 -1.41)	0.90	(0.76 -1.06)	0.98	(0.84 -1.14)	30
Northeast	AL	Capital	1.04	(0.91 -1.18)	1.29	(1.14 -1.45)	1.75	(1.60 -1.92)	280
		Inland	1.12	(1.02 -1.22)	1.03	(0.94 -1.13)	1.33	(1.23 -1.43)	235
	BA	Capital	1.05	(0.96 -1.14)	1.26	(1.17 -1.36)	1.62	(1.51 -1.72)	512
		Inland	1.00	(0.96 -1.05)	0.96	(0.91 -1.00)	0.81	(0.77 -0.85)	3
	CE	Capital	0.86	(0.80 -0.92)	1.36	(1.28 -1.43)	3.16	(3.04 -3.29)	2,151
		Inland	1.17	(1.10 -1.24)	1.11	(1.05 -1.18)	1.54	(1.47 -1.62)	837
	MA	Capital	0.97	(0.85 -1.11)	2.02	(1.85 -2.20)	2.19	(2.02 -2.37)	616
		Inland	1.09	(1.01 -1.18)	1.21	(1.13 -1.30)	1.90	(1.80 -2.01)	773
	PB	Capital	0.81	(0.71 -0.93)	0.85	(0.74 -0.97)	1.54	(1.39 -1.70)	132
		Inland	0.96	(0.89 -1.03)	0.89	(0.83 -0.96)	1.17	(1.10 -1.24)	162
	PE	Capital	0.91	(0.84 -0.99)	1.63	(1.53 -1.74)	2.37	(2.25 -2.49)	1,217
		Inland	1.06	(1.01 -1.10)	1.08	(1.04 -1.13)	1.50	(1.45 -1.55)	1,296
	PI	Capital	0.54	(0.43 -0.66)	0.67	(0.56 -0.80)	0.62	(0.52 -0.74)	0
		Inland	1.00	(0.91 -1.10)	0.88	(0.79 -0.97)	0.86	(0.77 -0.95)	0
	RN	Capital	0.85	(0.74 -0.97)	0.75	(0.65 -0.87)	1.10	(0.97 -1.25)	23
		Inland	1.00	(0.91 -1.09)	0.92	(0.84 -1.01)	1.15	(1.06 -1.25)	73
	SE	Capital	0.90	(0.77 -1.05)	0.87	(0.74 -1.02)	0.96	(0.82 -1.12)	0
		Inland	1.04	(0.93 -1.16)	0.87	(0.78 -0.98)	1.06	(0.95 -1.17)	32
Southeast	ES	Capital	1.04	(0.86 -1.26)	1.11	(0.91 -1.33)	1.37	(1.16 -1.60)	56
		Inland	0.95	(0.89 -1.01)	0.94	(0.88 -1.01)	1.20	(1.14 -1.27)	206
	MG	Capital	1.38	(1.29 -1.48)	1.28	(1.19 -1.38)	1.34	(1.25 -1.44)	555
		Inland	1.02	(0.99 -1.05)	0.90	(0.87 -0.93)	0.88	(0.85 -0.90)	103
	RJ	Capital	1.02	(0.98 -1.07)	1.51	(1.46 -1.56)	1.66	(1.61 -1.70)	3,089
		Inland	1.06	(1.02 -1.09)	1.11	(1.08 -1.15)	1.36	(1.32 -1.40)	1,830
	SP	Capital	1.11	(1.07 -1.14)	1.31	(1.27 -1.34)	1.42	(1.38 -1.46)	3,142
		Inland	1.01	(0.99 -1.03)	1.01	(0.99 -1.03)	1.09	(1.07 -1.11)	1.173
South	PR	Capital	1.04	(0.95 -1.13)	0.99	(0.90 -1.09)	0.96	(0.88 -1.05)	18
		Inland	1.05	(1.01 -1.09)	1.01	(0.97 -1.05)	0.89	(0.86 -0.93)	139
	RS	Capital	1.00	(0.93 -1.09)	0.93	(0.85 -1.01)	0.78	(0.72 -0.85)	3
		Inland	0.98	(0.94 -1.02)	0.94	(0.90 -0.98)	0.96	(0.92 -0.99)	0
	SC	Capital	0.85	(0.67 -1.06)	1.13	(0.91 -1.39)	0.79	(0.61 -0.99)	10
		Inland	1.01	(0.96 -1.06)	0.96	(0.91 -1.01)	0.92	(0.87 -0.96)	17

it continues

Table 1. Standardized Mortality Ratios (SMR) and number of excess deaths among men from capitals and inland municipalities of the federal units and Federal District, Brazil, March to May 2020. (continuation)

Region	State	Location	March		April		May		Excess deaths
			Ratio O/E	95% CI	Ratio O/E	95% CI	Ratio O/E	95% CI	
Midwest	DF	Capital	1.03	(0.95 -1.11)	0.92	(0.85 -1.00)	1.05	(0.97 -1.13)	49
	GO	Capital	0.84	(0.76 -0.93)	0.90	(0.81 -0.99)	0.90	(0.81 -0.98)	0
		Inland	1.11	(1.04 -1.19)	0.83	(0.78 -0.89)	1.02	(0.96 -1.09)	115
	MS	Capital	1.27	(1.12 -1.43)	0.98	(0.85 -1.11)	1.02	(0.90 -1.16)	63
		Inland	1.18	(1.08 -1.29)	1.07	(0.97 -1.17)	0.91	(0.83 -1.00)	96
	MT	Capital	1.14	(1.01 -1.28)	0.94	(0.82 -1.08)	0.92	(0.80 -1.06)	33
		Inland	0.93	(0.84 -1.02)	0.94	(0.85 -1.05)	0.82	(0.74 -0.91)	0
Brazil			1,03	(1,02 – 1,03)	1,10	(1,09 – 1,11)	1,24	(1,23 – 1,25)	23.979

Table 2. Standardized Mortality Ratios (SMR) and number of excess deaths among women from capitals and inland municipalities of the federal units and Federal District, Brazil, March to May 2020.

Region	State	Location	March		April		May		Excess deaths
			Ratio O/E	95% CI	Ratio O/E	95% CI	Ratio O/E	95% CI	
North	AC	Capital	1.26	(1.00 -1.55)	0.99	(0.77 -1.25)	2.25	(1.87 -2.68)	87
		Inland	0.83	(0.60 -1.12)	0.64	(0.45 -0.88)	0.96	(0.72 -1.26)	0
	AM	Capital	0.85	(0.77 -0.94)	2.65	(2.50 -2.81)	1.96	(1.83 -2.10)	1,080
		Inland	0.84	(0.60 -1.14)	1.23	(0.92 -1.61)	2.71	(2.22 -3.26)	78
	AP	Capital	0.42	(0.28 -0.59)	0.54	(0.39 -0.73)	1.18	(0.94 -1.45)	13
		Inland	0.86	(0.53 -1.34)	0.75	(0.47 -1.13)	1.25	(0.88 -1.74)	7
	PA	Capital	1.09	(0.99 -1.19)	2.22	(2.07 -2.37)	2.45	(2.29 -2.62)	994
		Inland	0.78	(0.71 -0.86)	0.82	(0.74 -0.90)	1.22	(1.13 -1.31)	118
	RO	Capital	96.16	(78.15 -117.07)	0.83	(0.67 -1.03)	2.74	(2.40 -3.12)	245
		Inland	0.85	(0.72 -1.00)	0.74	(0.63 -0.87)	0.85	(0.72 -0.99)	0
	RR	Capital	1.12	(0.87 -1.43)	1.10	(0.85 -1.39)	1.43	(1.18 -1.73)	47
		Inland	2.86	(1.60 -4.72)	1.64	(0.66 -3.37)	2.49	(1.07 -4.90)	17
	TO	Capital	0.66	(0.46 -0.92)	0.65	(0.45 -0.92)	0.86	(0.55 -1.28)	0
		Inland	1.49	(1.26 -1.74)	0.83	(0.68 -1.00)	0.91	(0.76 -1.08)	49
Northeast	AL	Capital	0.90	(0.78 -1.03)	1.05	(0.92 -1.19)	1.47	(1.33 -1.62)	145
		Inland	1.01	(0.90 -1.12)	0.90	(0.81 -1.00)	1.38	(1.27 -1.50)	153
	BA	Capital	0.89	(0.81 -0.97)	1.37	(1.27 -1.48)	1.52	(1.43 -1.63)	486
		Inland	0.94	(0.89 -0.99)	0.89	(0.84 -0.94)	0.73	(0.69 -0.77)	0
	CE	Capital	0.94	(0.87 -1.00)	1.39	(1.31 -1.47)	2.50	(2.40 -2.61)	1,571
		Inland	1.01	(0.94 -1.08)	1.02	(0.95 -1.09)	1.34	(1.27 -1.42)	325
	MA	Capital	0.83	(0.72 -0.95)	1.65	(1.49 -1.82)	1.55	(1.41 -1.70)	307
		Inland	1.02	(0.93 -1.12)	1.07	(0.98 -1.18)	1.43	(1.33 -1.54)	251
	PB	Capital	0.77	(0.66 -0.90)	0.80	(0.69 -0.92)	0.91	(0.80 -1.03)	0
		Inland	0.96	(0.89 -1.03)	0.85	(0.79 -0.92)	1.09	(1.02 -1.16)	75
	PE	Capital	1.02	(0.95 -1.10)	1.54	(1.44 -1.64)	2.02	(1.91 -2.12)	1,062
		Inland	1.05	(1.00 -1.10)	1.10	(1.05 -1.15)	1.38	(1.33 -1.44)	948
	PI	Capital	0.71	(0.58 -0.85)	0.76	(0.63 -0.91)	0.45	(0.36 -0.55)	0
		Inland	1.03	(0.93 -1.14)	0.80	(0.72 -0.90)	0.71	(0.62 -0.80)	10
	RN	Capital	0.80	(0.69 -0.93)	0.63	(0.53 -0.74)	0.94	(0.83 -1.08)	0
		Inland	1.18	(1.07 -1.30)	0.91	(0.82 -1.00)	1.00	(0.91 -1.10)	65
	SE	Capital	1.08	(0.93 -1.25)	0.77	(0.64 -0.92)	1.01	(0.87 -1.18)	15
		Inland	0.96	(0.85 -1.08)	0.91	(0.80 -1.03)	0.91	(0.80 -1.02)	0

it continues

Table 2. Standardized Mortality Ratios (SMR) and number of excess deaths among women from capitals and inland municipalities of the federal units and Federal District, Brazil, March to May 2020. (continuation)

Region	State	Location	March		April		May		Excess deaths
			Ratio O/E	95% CI	Ratio O/E	95% CI	Ratio O/E	95% CI	
Southeast	ES	Capital	1.03	(0.84 -1.25)	1.05	(0.85 -1.27)	1.00	(0.84 -1.19)	7
		Inland	0.95	(0.89 -1.02)	1.04	(0.96 -1.11)	1.20	(1.13 -1.28)	189
	MG	Capital	1.51	(1.40 -1.61)	1.23	(1.14 -1.33)	1.15	(1.06 -1.24)	484
		Inland	1.02	(0.99 -1.06)	0.89	(0.86 -0.92)	0.88	(0.85 -0.90)	97
	RJ	Capital	1.00	(0.96 -1.04)	1.25	(1.20 -1.29)	1.38	(1.33 -1.42)	1,782
		Inland	1.02	(0.98 -1.06)	1.03	(1.00 -1.07)	1.23	(1.20 -1.27)	939
	SP	Capital	1.08	(1.05 -1.12)	1.27	(1.23 -1.31)	1.33	(1.29 -1.37)	2,385
		Inland	1.03	(1.01 -1.05)	0.96	(0.94 -0.98)	1.05	(1.03 -1.07)	698
South	PR	Capital	0.97	(0.88 -1.07)	1.05	(0.95 -1.16)	0.91	(0.82 -1.00)	21
		Inland	1.10	(1.06 -1.15)	0.94	(0.90 -0.99)	0.86	(0.83 -0.90)	186
	RS	Capital	0.97	(0.90 -1.05)	0.96	(0.88 -1.04)	0.78	(0.72 -0.85)	0
		Inland	1.02	(0.98 -1.06)	0.92	(0.88 -0.95)	0.97	(0.94 -1.01)	43
	SC	Capital	0.92	(0.73 -1.14)	1.04	(0.83 -1.30)	1.03	(0.82 -1.27)	5
		Inland	0.96	(0.91 -1.01)	0.92	(0.87 -0.98)	0.88	(0.83 -0.92)	0
Midwest	DF	Capital	1.06	(0.97 -1.15)	0.93	(0.86 -1.02)	0.94	(0.86 -1.02)	29
	GO	Capital	0.99	(0.89 -1.09)	0.90	(0.80 -1.00)	0.94	(0.84 -1.04)	0
		Inland	1.05	(0.97 -1.13)	0.89	(0.82 -0.96)	0.96	(0.89 -1.04)	32
	MS	Capital	1.06	(0.93 -1.21)	0.69	(0.59 -0.81)	0.78	(0.67 -0.90)	13
		Inland	1.22	(1.10 -1.35)	0.88	(0.78 -0.98)	0.81	(0.72 -0.91)	67
	MT	Capital	1.22	(1.07 -1.40)	0.74	(0.63 -0.87)	1.01	(0.86 -1.18)	41
		Inland	0.99	(0.88 -1.13)	0.87	(0.75 -0.99)	0.67	(0.58 -0.77)	0
Brazil			1,02	(1,01 – 1,03)	1,04	(1,03 – 1,05)	1,14	(1,13 – 1,15)	15.167

Brazilian capitals recorded no excess deaths for both genders, namely Palmas (TO), Teresina (PI), and Goiânia (GO) (Figures 1 and 2).

Incremental and statistically significant standardized mortality ratios were observed for most capitals in the Northeast and Southeast regions for men and Southeast for women in April. In May, most capitals in the North region followed the same pattern. For the other municipalities, the standardized mortality ratios indicated a significant increase in May, highlighting the inland region of the states of the North, Northeast, and Southeast regions (Tables 1 and 2, Figures 1 and 2).

Discussion

The total of excess deaths estimated in this study between March and May 2020 (39,146) across the country was 33.5% higher than the number of deaths accumulated by COVID-19 as of May 31, as reported by the Ministry of Health (29,314 deaths)[11]. In the state capitals, the excess deaths for the period studied were 124% higher than in the other municipalities in the country, ranging from 3 in Porto Alegre to 5,527 in São Paulo.

A continued increase was observed in the standardized mortality ratios for each month analyzed in 2020 in the places where increased mortality was noted compared to the same months of the previous year. This increase coincided with the escalating epidemic in the country. The compared standardized mortality ratios for the states, separating capitals from other municipalities, allows observing a great regional variation with higher magnitude in the capitals and more significant excess among men from March to May 2020.

However, in May, the inland region's standardized mortality ratios became more expressive, which may be associated with the in-

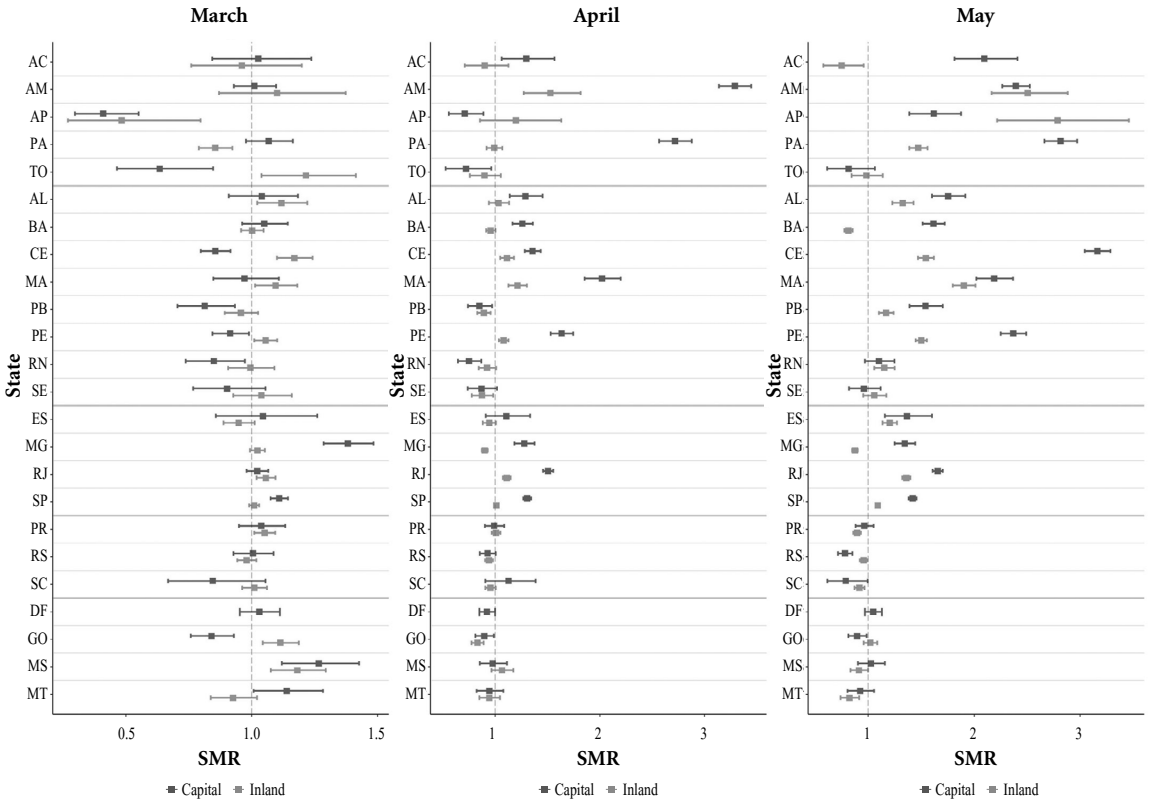

Figure 1. Standardized Mortality Ratios (SMR) and 95% confidence intervals among men from capitals and inland municipalities of the federal units and Federal District, Brazil, March to May 2020.

land-bound transmission of COVID-19. This is consistent with the introduction of SARS-COV-2 that started in the capitals but has been spreading inland. The mortality profile changed initially in the capitals of the Southeast, North, and Northeast regions. The epidemic shift allowed perceiving excess deaths in municipalities outside the capitals, which may reflect the arrival of COVID-19.

Although COVID-19 is less lethal than SARS, it has a higher transmissibility power and affects mainly elderly individuals, men, and those with comorbidities[12]. However, compared to the influenza virus, SARS-CoV-2 is more transmissible, with an approximate lethality of 1.4% and is 14 times higher. In China, the general ratio of fatal cases was 1.38% (1.23–1.53), with higher proportions in older groups (above 60 years: 6.4%, 95% CI: 5.7–7.2; and above 80 years: 13.4%, 95% CI: 11.2–15.9)[13].

The findings of this study identify excess deaths among men, compared to what was observed among women, which agrees with what has been reported in the literature[14]. However, attention is drawn to the need to analyze more robust estimates, assessing the absolute and relative differences to understand this issue better[15].

The data made available by ARPEN, derived from information from Civil Registry Offices for Natural Persons, do not allow a reliable analysis of the underlying causes of death, and, therefore, it was not possible to group data by cause. They do, however, have the advantage of accessing information from 2019 and 2020. The excess of 33.5% found between the estimated deaths in 2020 compared to deaths officially reported by COVID-19 may be, in part, explained by indirect causes. In the context of the pandemic, the conditions of health of persons with comorbidities, or even difficulties in accessing health ser-

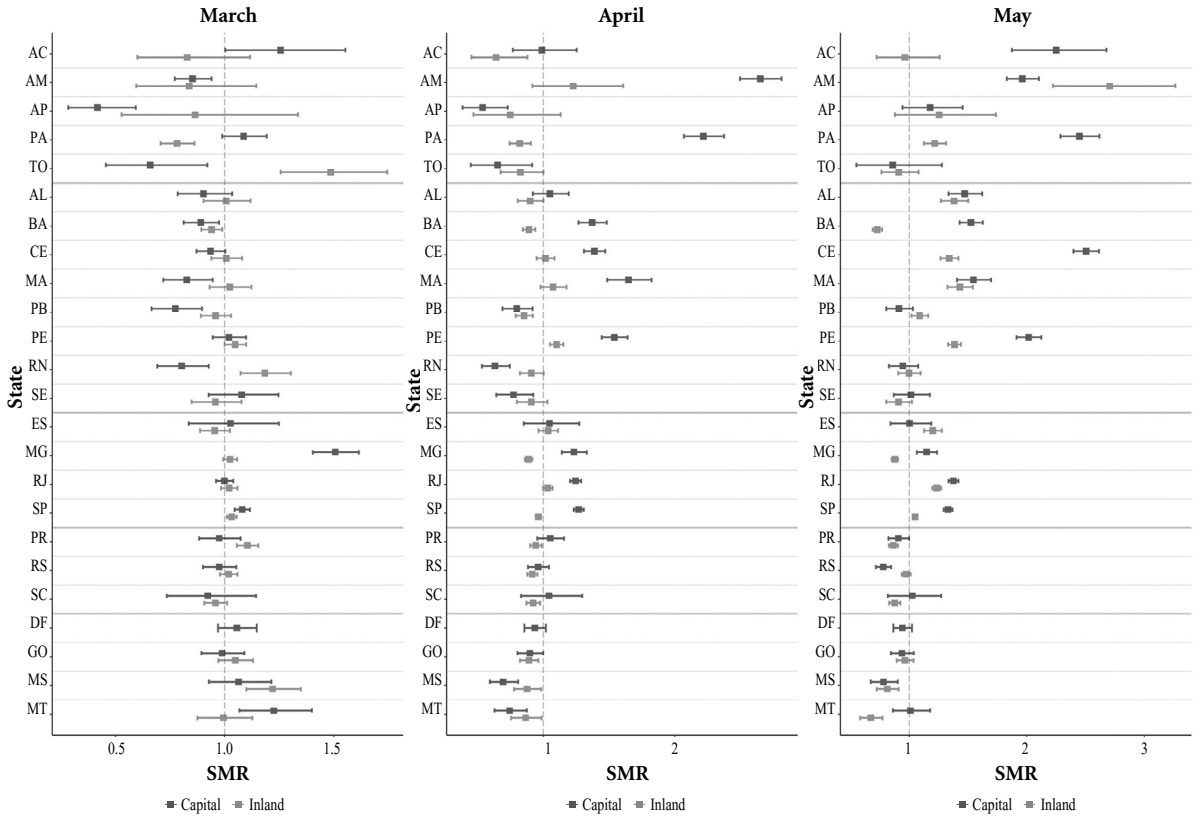

Figure 2. Standardized Mortality Ratios (SMR) and 95% confidence intervals among women from capitals and inland municipalities of the federal units and Federal District, Brazil, March to May 2020.

vices that are primarily treating COVID-19 cases, can explain deaths from other causes which are indirectly caused by the pandemic. A study that analyzed mortality in the first weeks of the pandemic (between March 1 and April 25, 2020) and the contribution of COVID-19 and other causes in the U.S. showed 87,001 excess deaths against the total of 505,059 deaths, 56,246 (65%) of which were attributed to COVID-19. This study identified that, in the five states with the highest number of deaths due to COVID-19, there was also a substantial increase in mortality from other non-respiratory causes such as diabetes and heart disease[16].

The World Health Organization draws attention to the Situation Report (the final part with the update of data and errata of specific countries, territories or areas) about the significant increase observed in Brazil on June 21 due to the case report lag in three states (Bahia, Rio de Janeiro, and São Paulo)[17]. Brazil ranks second regarding the number of deaths in the table of this report, behind the U.S. (Brazil: 48,954 and the U.S.: 118,895). However, the number of new cases and deaths confirmed in the last 24 hours is, by far, much higher than in any other country (54,771 new cases and 1,206 deaths), ranking first in this regard, followed by the U.S. (36,617 new cases in the last 24 hours). These data are alarming and the burden of COVID-19 in the country should be much higher if we take into account the considerable underreporting due to the disarticulated control and the lack of testing on a larger scale.

The analysis presented here has several relevant limitations. Estimates are based on incomplete, provisional data. The exclusion of data from the last 14 days of the time series may not be enough to consider the delay in some municipalities or states. For example, in the state of Rondônia, the delays in notification or system update appear to be longer and more unstable

and, therefore, the count may still be underestimated. The estimates can be an early indication of the disease burden, but they must be interpreted with caution until confirmed by other official data sources, such as the Mortality Information System (SIM)[18]. However, with all the limitations, the results point to excess deaths between March and May, precisely after the epidemic arrives in Brazil, and, therefore, can be associated with COVID-19.

The need to improve the detection and registration of cases is urgent, and health authorities are responsible for providing conditions for this to be done with regularity, daily updating, and transparency to ensure the pandemic's monitoring. The maintenance and constant improvement of our health information systems must be seen as a priority in all spheres of government, lest we lose what has been built for several decades with so much effort and has been the most consistent pillar for disease control in the country.

Collaborations

GA Silva, BC Jardim and CVB Santos participated equally in all stages of writing the article.

Acknowledgments

We thank Marcelo Oliveira (https://github.com/capyvara) for the extraction and compilation of data from the Civil Registry, and Flávio Henrique M. de A. Freire and a colleagues from the Laboratory of Estimates and Population Projections at the UFRN, for making available the population projections.

References

1. Roser M, Ritchie H, Ortiz-Ospina E, Hasell J. *Coronavirus Pandemic (COVID-19)*. [acessado 2020 Jul 3]. Disponível em: https://ourworldindata.org/coronavirus
2. De Wit E, Van Doremalen N, Falzarano D, Munster VJ. SARS and MERS: Recent insights into emerging coronaviruses. *Nat Rev Microbiol* 2016; 14(8):523-534.
3. Dong E, Du H, Gardner L. An interactive web-based dashboard to track COVID-19 in real time. *Lancet Infect Dis* 2020; 20(5):533-534.
4. Brasil. Ministério da Saúde (MS). Secretaria de Vigilância em Saúde (SVS). *Boletim Epidemiológico Especial Nº 16*. Brasília: MS; 2020. [acessado em 2020 Jul 3]. Disponível em https://portalarquivos.saude.gov.br/images/pdf/2020/May/21/2020-05-19---BEE16---Boletim-do-COE-13h.pdf.
5. Brasil. Ministério da Saúde (MS). *Painel Coronavírus*. Brasília: MS; 2020. [acessado 2020 Jul 3]. Disponível em: https://covid.saude.gov.br/
6. Associação dos Registradores de Pessoas Naturais (ARPEN). *Portal da Transparência - Registro Civil*. [acessado 2020 Jun 30]. Disponível em: https://transparencia.registrocivil.org.br
7. Brasil. Lei Nº 6.015, de 31 de Dezembro de 1973. Dispõe sobre os registros públicos, e dá outras providências. *Diário Oficial da União* 1973; 31 dez.
8. Freire FHMA, Gonzaga MR, Gomes MMF. Projeções populacionais por sexo e idade para pequenas áreas no Brasil. *Rev Latinoam Población* 2019; 14(26):124-149.
9. Breslow NE, Day NE. Statistical Methods in Cancer Research. In: Breslow NE, Day NE. *Vol. 2 - The Design and Analysis of Cohort Studies*. Lyon: IARC ed.; 1987. p. 69-71.
10. StataCorp. *Stata Statistical Software: Release 14*. College Station: StataCorp; 2015.
11. Brasil. Ministério da Saúde (MS). *Coronavírus: mais de 200 mil pessoas estão curadas no Brasil*. 2020. [acessado 2020 Jul 3]. Disponível em: https://www.saude.gov.br/noticias/agencia-saude/46987-coronavirus-mais-de-200-mil-pessoas-estao-curadas-no-brasil-2
12. Yi Y, Lagniton PNP, Ye S, Li E XR. COVID-19: what has been learned and to be learned about the novel coronavirus disease. *Int J Biol Sci* 2020; 10(16):1753-1766.
13. Verity R, Okell LC, Dorigatti I, Winskill P, Whittaker C, Imai N, Cuomo-Dannenburg G, Thompson H, Walker PGT, Fu H, Dighe A, Griffin JT, Baguelin M, Bhatia S, Boonyasiri A, Cori A, Cucunubá Z, FitzJohn R, Gaythorpe K, Green W, Hamlet A Hinsley W, Laydon D, Nedjati-Gilani G, Riley S, van Elsland S, Volz E, Wang H, Wang Y, Xi X, Donnelly CA, C Ghani AC, Ferguson NM. Estimates of the severity of coronavirus disease 2019: a model-based analysis. *Lancet Infect Dis* 2020; 20(6):669-677.
14. Krieger N, Chen JT, Waterman PD. Excess mortality in men and women in Massachusetts during the COVID-19 pandemic. *Lancet*. 2020; 395(10240):1829.
15. The Lancet. The gendered dimensions of COVID-19. *Lancet* 2020; 395(10231):1168.
16. Woolf SH, Chapman DA, Sabo RT, Weinberger DM, Hill L. Excess Deaths From COVID-19 and Other Causes, March-April 2020. *JAMA* 2020; Jul 1.
17. World Health Organization (WHO). *Coronavirus Disease 2019 (COVID-19): Situation Report - 153*. Geneva: WHO; 2020.
18. Brasil. Ministério da Saúde (MS). *Sistema de Informações sobre Mortalidade - SIM*. 2020. [acessado 2020 Jul 3]. Disponível em: http://datasus.saude.gov.br/

Article submitted 03/07/2020
Approved 03/07/2020
Final version submitted 05/07/2020