Publication status: Preprint has been published in a journal as an article
DOI of the published article: https://doi.org/10.25110/arqsaude.v27i5.2023-062

The impact of socioeconomic vulnerability on COVID-19 outcomes and social distancing in Brazil

Paulo Cardoso Lins-Filho, Millena Mirella Silva de Araújo, Thuanny Silva de Macêdo, Maria Cecília Freire de Melo, Andressa Kelly Alves Ferreira, Elizabeth Louisy Marques Soares da Silva, Jaciel Leandro de Melo Freitas, Arnaldo de França Caldas Jr

https://doi.org/10.1590/SciELOPreprints.1126

Submitted on: 2020-08-20
Posted on: 2020-08-21 (version 1)
(YYYY-MM-DD)

Original Article

Impact of socioeconomic vulnerability on COVID-19 outcomes and social distancing in Brazil

Paulo Cardoso Lins-Filho[1], Millena Mirella Silva de Araújo[1], Thuanny Silva de Macêdo[1], Maria Cecília Freire de Melo[1], Andressa Kelly Alves Ferreira[1], Elizabeth Louisy Marques Soares da Silva[1], Jaciel Leandro de Melo Freitas[1], Arnaldo de França Caldas Jr[1,2].

[1] Universidade Federal de Pernambuco, Recife, Pernambuco, Brazil

[2] Universidade de Pernambuco, Camaragibe, Pernambuco, Brazil

Corresponding Author:

PhD Arnaldo de França Caldas Jr (https://orcid.org/0000-0002-3713-7532)

Address for correspondence: Estrada de Aldeia, Km 13, Prive Portal de Aldeia, Aldeia, Camaragibe, Pernambuco, Brazil. Tel: +55 (81) 999713652

E-mail: caldasjr@alldeia.com.br

Other authors e-mail:

paulocardoso09@hotmail.com (http://orcid.org/0000-0002-1809-7168)

millenamirella@hotmail.com (https://orcid.org/0000-0001-5612-6954)

thuannymacedo16@gmail.com (https://orcid.org/0000-0003-0036-3971)

mceciliafreire@hotmail.com (https://orcid.org/0000-0002-9592-4796)

andressaa.kelly@gmail.com (https://orcid.org/0000-0002-7106-2108)

beth_louisy@hotmail.com (https://orcid.org/0000-0002-1093-9367)

jacielsanguiar@hotmail.com (https://orcid.org/0000-0002-4957-5206)

Conflict of interest: None.

Authors Contribution: All Authors contributed equally for the present study.

ABSTRACT

Objective: To assess the impact and correlation of socioeconomic vulnerability on COVID-19 outcomes and social distancing in Brazil. **Methods:** The Gini Coefficient (GC), the Social Vulnerability Index (SVI), epidemiological data on COVID-19 epidemic in Brazil, and the Social Distancing Index (SDI) were retrieved from online databases and assessed for each Brazilian state. Data was statistically analyzed through non-parametric tests and multiple linear regressions. **Results:** The mean values for the GC and SVI were 0.495 and 0.261, respectively. A positive statistically significant correlation between the socioeconomic indicators and the three variables related to the COVID-19 outbreak was found. States with very low social vulnerability presented fewer deaths per 100 thousand inhabitants due to COVID-19 than states with moderate social vulnerability. SVI was a predictor of accumulated cases, confirmed deaths, and social distancing in Brazilian states during COVID-19. **Conclusions:** The COVID-19 outcomes and SDI in Brazilian states are correlated to the socioeconomic condition. The pandemic impacts are more severe in less favored communities.

Keywords: COVID-19; Health Status Disparities; Social Determinants of Health; Pandemic; Economic Status.

RESUMO

Objetivo: Avaliar o impacto e a correlação da vulnerabilidade socioeconômica nos desfechos da COVID-19 e no distanciamento social no Brasil. **Materiais e Métodos:** O Coeficiente de Gini (CG), o Índice de Vulnerabilidade Social (IVS), dados epidemiológicos sobre a epidemia da COVID-19 no Brasil e o Índice de Distanciamento Social (IDS) foram obtidos a partir de bases de dados online e avaliados para cada estado brasileiro. Os dados foram analisados estatisticamente através de testes não-paramétricos e de regressão logística linear. **Resultados:** Os valores médios para o CG e IVS foram 0.495 e 0.261, respectivamente. Uma correlação estatística positiva foi encontrada entre os indicadores socioeconômicos e as três variáveis relacionadas à epidemia de COVID-19. Os estados brasileiros com menores índices de vulnerabilidade social apresentaram uma quantidade menor de mortes pela COVID-19, para cada cem mil habitantes, quando comparados com estados com vulnerabilidade social moderada. O IVS foi um preditor para o acumulado de casos, mortes confirmadas e distanciamento social nos estados brasileiros durante a pandemia da COVID-19. **Conclusão:** Os desfechos da COVID-19 e o IDS nos estados brasileiros estão correlacionados com a condição socioeconômica. Os impactos da pandemia são mais severos nas localidades mais vulneráveis.

Palavras-Chave: COVID-19; Disparidades nos Níveis de Saúde; Determinantes Sociais de Saúde; Pandemia; Status Socioeconômico.

INTRODUCTION

Less than four months after the first confirmed case of the 2019 novel coronavirus disease (COVID-19) in Brazil, the country reaches the mark of more than one million accumulated cases, and over 50.000 confirmed deaths [1]. These numbers are estimated to be even greater, considering the likely occurrence of underreporting as the country is testing only severe cases [2]. During the pandemic, the country has been facing a political crisis, which has been misleading the efforts to mitigate COVID-19 spread and its socioeconomic impacts [3].

Brazil is the largest and most populous Latin-American country; its continental dimension favors to diversity in socioeconomic and geographical aspects [4]. Each Brazilian region is different, based on social behavior, genetics, and economic backgrounds raising the need for different measures and health policies to direct medical resources, and to manage social issues, respecting each area's particularities [2].

All regions in Brazil have confirmed cases of COVID-19 [1]. There is a socioeconomic disparity among regions corroborating several issues related with COVID-19 pandemic such as access and understanding of information about the disease, availability of diagnostic tests, health human resources, and intensive care units, besides the political decisions to control the pandemic [2,3].

Despite statements like "COVID-19 virus does not discriminate", made by some politicians and part of the media, COVID-19 is not a socially neutral disease [5]. Special attention must be paid to vulnerable populations, since recent reports indicate that incidence and deaths are disproportionately affecting less favored communities [6,7,8]. Scientific evidence and broader surveillance are in urgent need to improve response and planning, such as resources allocation, to tackle health inequities in the current COVID-

19 pandemic [9]. Thus, the present study aims to assess the impact and correlation of socioeconomic vulnerability on COVID-19 outcomes and social distancing in Brazil.

METHODS

The Gini Coefficient (GC) and the Social Vulnerability Index (SVI) were adopted as socioeconomic indicators. The values scored in these indicators for each Brazilian state were retrieved from the online database of the Brazilian Institute of Geography and Statistics [10] and the Institute of Applied Economic Research [11], respectively. In addition to socioeconomic indicators epidemiological data on COVID-19 epidemic in Brazil and the Social Distancing Index (SDI) were assessed for each Brazilian state.

The GC is a measure of statistical dispersion used in economics intended to represent the income or wealth distribution among residents of a certain area and is the most used measurement of inequality. This indicator has been applied in the health field to measure disparities. The GC value ranges from 0 (perfect equality, where every household earns the same income) to 1.0 (perfect inequality, where households earn a diverse range of incomes) [12].

The SVI is an index that seeks to highlight different indicatives of exclusion and social vulnerability in a perspective that goes further the comprehension of poverty only as insufficient monetary resources. Thus, the SVI intends to signal the access, absence, or insufficiency of some “assets” in areas of the Brazilian territory, which should be available to every citizen, by virtue of State action. The three sub-indices that comprise it are urban infrastructure, human capital, and income and labor. Those sub-indices represent three large sets of assets, whose possession or deprivation determines the conditions of well-being of populations in contemporary societies. The index value ranges from 0 to 1, the closer to 1, the greater the social vulnerability of a region. Values between

0 and 0.200, indicate very low social vulnerability; between 0.201 and 0.300 indicate low social vulnerability; between 0.301 and 0.400 indicate moderate social vulnerability; between 0.401 and 0.500 indicate high social vulnerability; and between 0.501 and 1 indicate very high social vulnerability [13].

Epidemiological data concerning accumulated cases and confirmed deaths (per 100 thousand inhabitants) due to COVID-19 in each state were collected from the Brazilian government Health Ministry database, available online [1]. The data used in this research comprises information from February 25, 2020 (first case recorded in Brazil) to June 20, 2020.

The SDI was created to help mitigate the spread of COVID-19, since its launch, it has been improved with the sole objective of providing increasingly accurate data for public authorities and research institutes. To achieve the index, highly accurate geolocation data was treated with a distance algorithm. Polygons from all regions of the IBGE were adopted to ensure a more accurate categorization and more reliable data [14]. Data is available on the Inloco website (https://mapabrasileirodacovid.inloco.com.br/pt/) displayed as a map and chart. SDI values are represented in percentual of social distancing, ranging from 0 to 100%.

Data were submitted to statistical analysis, all tests were applied considering an error of 5% and the confidence interval of 95%, and the analyzes were carried out using SPSS software version 23.0 (SPSS Inc. Chicago, IL, USA). As the hypothesis of normal distribution of data was not confirmed by the Kolmogorov-Smirnov test, the statistical analysis was performed through the application of nonparametric tests. The strength of the association between distinct measures was tested with Spearman rank correlation. States in different groups according with SVI categorization were compared by Kruskal-Wallis test and post-hoc Dunn test. Multiple linear regressions were performed to verify

whether GC or SVI were predictors of accumulated cases, confirmed deaths, and social distancing index in Brazilian states during COVID-19 outbreak.

RESULTS

For the period evaluated, the mean of accumulated cases and confirmed deaths per 100 thousand inhabitants in the Brazilian states was approximately 697 and 24, respectively. The states mean SDI score was 38.77%. Regarding the socioeconomic indicators, the mean values for the GC and SVI were, respectively, 0.495 and 0.261, as shown in table 1. The SVI values ranged from 0.134 to 0.374, thus none of the states presented high or very high social vulnerability.

The comparison among states with different social vulnerability indices found statistically significant differences in the number of deaths. States with very low social vulnerability presented fewer deaths per 100 thousand inhabitants due to COVID-19 than states with moderate social vulnerability, as shown in table 2.

The Spearman correlation test found a positive statistically significant correlation between the socioeconomic indicators and the three variables related to the COVID-19 outbreak in Brazil, except for the correlation between the GC and confirmed deaths (table 3).

The analysis of multiple linear regressions resulted in statistically significant models where the SVI was a predictor of accumulated cases, confirmed deaths, and social distancing index in Brazil during COVID-19 epidemic. Higher SVI, indicative of greater social vulnerability, was associated with higher accumulated cases ($\beta = 0.409$; $t=2.243$; $p=0.034$), confirmed deaths ($\beta = 0.498$; $t=2.874$; $p=0.008$), and social distancing index ($\beta = 0.544$; $t=3.242$; $p=0.003$). The values that describe these relationships are shown in table 4.

DISCUSSION

Health inequities are a worldwide issue [5]. The COVID-19 pandemic can affect the whole of society, however, its repercussions will be experienced in different ways, depending on the level of equity that exists in each social reality [15]. The findings of the present study support this statement since areas with different socioeconomic conditions are not being proportionally affected in Brazil.

The number of confirmed deaths due to COVID-19 presented a positive correlation with GC and SVI (table 3). In addition, states with moderate social vulnerability presented an average of 30 deaths per 100 thousand inhabitants more than states with very low social vulnerability (table 2). Furthermore, greater social vulnerability was a predictor of increase in deaths (table 4). These findings demonstrate the impact of socioeconomic vulnerability on COVID-19 mortality. Vulnerable communities are also disproportionately affected by preexisting chronic conditions. Studies carried out in Brazilian populations found that in areas with more marked poverty or inequality a higher prevalence of hypertension [16], diabetes [17], cancer [18], asthma [19], and multiple comorbidities[20] were observed, those conditions represent an increased risk for severe COVID-19 health outcomes [21, 22]. In addition, the availability of resources such as diagnostic tests, intensive care units, and health human resources are not equally distributed in the Brazilian territory [2].

Risk communication is an integral element of any public health emergency response [23], however, vulnerable populations may not have the necessary language and literacy skills to understand and appropriately respond to pandemic messaging [15] because low health literacy is more prevalent among vulnerable populations [24]. This may be associated with the difficulty to control the spread of COVID-19, particularly in regions of greater social vulnerability. In addition, lower sanitary standards, and the inability to maintain

social distancing due to the need to leave home in search of work and income increase the exposure risk of people in social vulnerability. In the present study income inequality and social vulnerability showed a positive correlation with the cumulative cases of COVID-19 (table 3). SVI was a predictor of increased cases per 100 thousand inhabitants in Brazilian states (table 4). These findings support studies that alert to health inequalities during COVID-19 pandemic [5, 25].

Social distancing measures to control the spread of COVID-19 are likely to have large effects on health and health inequalities [26]. Countries worldwide have implemented rigorous isolation measures in response to the pandemic. The aim of social distancing is to mitigate transmission by reducing close contact, however, the measures have profound socioeconomic and health consequences [26]. In Brazil, according to the present investigation, the SDI is correlated to the socioeconomic status, as shown in table 3. In addition, greater social vulnerability was predictor of increased SDI in Brazilian states. Since socioeconomic disparities are an aggravating factor in the course of the health crisis, it is expected that, in response to higher rates of cases and deaths, as shown by the findings of the present study, more stricter measures of social distancing are implemented in more vulnerable areas.

Social distancing has led to a reduced workforce in all economic sectors and has caused job losses, resulting in income losses for workers unable to work and increased long-term unemployment if companies fail [26, 27]. Isolation measures should be thoughtfully planned and executed, policymakers must consider its broader effects on health and health equity, otherwise, the decrease in income will exacerbate the pre-existing socioeconomic disparities, deepening the problems of local health inequity in epidemic areas [9, 28].

Besides the immediate health effects for the vulnerable populations, the pandemic will certainly have long-term socioeconomic impacts on less favored communities [9]. The public health policy responses must ensure that considerations of health equity and social justice principles remain at the forefront of pandemic responses to ensure that the COVID-19 pandemic does not increase health inequalities for future generations [5].

CONCLUSIONS

The COVID-19 outcomes and SDI in Brazilian states are correlated to the socioeconomic condition. States with moderate social vulnerability presented more deaths per 100 thousand inhabitants than states with very low social vulnerability. SVI was a predictor of accumulated cases, confirmed deaths, and social distancing index in Brazilian states during COVID-19. Health authorities might apply these data on disease-control efforts, guiding interventions and resource allocations to improve outcomes in vulnerable communities.

ACKNOWLEDGMENTS

The authors would like to thank the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) for scholarship granting.

REFERENCES

1. Brazilian Health Ministry. *Painel Coronavírus (2020)* [accessed 20/06/2020]. Available at: https://covid.saude.gov.br/.
2. Marson FL, Ortega M. COVID-19 in Brazil. *Pulmonology* 2020; 26(4):241-244.
3. The Lancet. COVID-19 in Brazil: "So What?". *Lancet* 2020; 395(1): 1461.
4. The Brazilian EPIGEN Project Consortium. Origin and dynamics of admixture in Brazilians and its effect on the pattern of deleterious mutations. *PNAS* 2015; 112 (28): 8696-8701.
5. Bambra C, Riordan R, Ford J, Matthews F. The COVID-19 pandemic and health inequalities. *J Epidemiol Community Health* 2020; 0: 1-5.
6. Dorn A, Cooney RE, Sabin ML. COVID-19 exacerbating inequalities in the US. *Lancet* 2020; 395(10232):1243-1244.
7. Turner-Musa J, Ajayi O, Kemp L. Examining Social Determinants of Health, Stigma, and COVID-19 Disparities. *Healthcare* 2020; 8: 1-7.
8. Dyer O. Covid-19: Black People and Other Minorities Are Hardest Hit in US. *BMJ* 2020; 369: 1-2.
9. Wang Z, Tang K. Combating COVID-19: Health Equity Matters. *Nature* 2020; 26: 458–464.
10. Brazilian Institute of Geography and Statistics (IBGE). *Continuous National Household Sample Survey - Continuous PNAD*. Brasília: 2019.
11. Institute of Applied Economic Research (IPEA). *Atlas of Social Vulnerability*. Brasília: 2017.
12. Pabayo R, Chiavegatto Filho ADP, Lebrão ML, Kawachi I. Income Inequality and Mortality: Results From a Longitudinal Study of Older Residents of São Paulo, Brazil. *Am J Public Health* 2013; 103(9):43-49.

13. Institute of Applied Economic Research (IPEA). *Atlas of social vulnerability in Brazilian municipalities*. Brasília: 2015.
14. Inloco. *Mapa brasileiro da COVID-19* [accessed 23/05/2020]. Available at: https://mapabrasileirodacovid.inloco.com.br/pt/.
15. Smith JA, Judd J. COVID-19: Vulnerability and the power of privilege in a pandemic. *Health Promot J Austr* 2020; 31:158-160.
16. Santos DMS, Prado BS, Oliveira CCC, Almeida-Santos MA. Prevalence of Systemic Arterial Hypertension in Quilombola Communities, State of Sergipe, Brazil. *Arq Bras Cardiol* 2019; 113(3):383-390.
17. Meiners M et al, Tavares NUL, Guimarães LSP, Bertoldi AD, Dal Pizzol TS, Luiza VL, Mengue SS, Merchan-Hamann E. Access and Adherence to Medication Among People with Diabetes in Brazil: Evidences from PNAUM. *Rev Bras Epidemiol* 2017; 20(3):445-459.
18. Barbosa IR, Souza DL, Bernal MM, Costa ICC. Cancer mortality in Brazil: Temporal Trends and Predictions for the Year 2030. *Medicine (Baltimore)* 2015; 94(16): 1-6.
19. Cunha SS, Pujades-Rodriguez M, Barreto ML, Genser B, Rodrigues LC. Ecological study of socio-economic indicators and prevalence of asthma in schoolchildren in urban Brazil. *BMC Public Health* 2007; 7(1): 1-6.
20. Cabral JF, Silva AMC, Mattos IE, Neves AQ, Luz LL, Ferreira DB, Santiago LM, Carmo CN. Vulnerability and Associated Factors Among Older People Using the Family Health Strategy. *Cien Saude Colet* 2019; 24(9): 3227-3236.
21. Xu PP, Luo S, Tian RH, Zu ZY. Risk Factors for Adverse Clinical Outcomes with COVID-19 in China: A Multicenter, Retrospective, Observational Study. *Theranostics* 2020; 10(14):6372-6383.

22. China Medical Treatment Expert Group for COVID-19. Comorbidity and its impact on 1590 patients with COVID-19 in China: a nationwide analysis. *Eur Respir J* 2020; 55(5): 1-14.
23. Shrivastava SR, Shrivastava PS, Ramasamy J. Risk Communication: An Integral Element in Public Health Emergencies. *Int J Prev Med* 2016; 7(1): 1-2.
24. Lynch M, Franklin G. Strategies to Reduce Hospital Mortality in Lower and Middle Income Countries (LMICs) and Resource-Limited Settings. *IntechOpen* 2020.
25. Ramírez I, Lee J. COVID-19 Emergence and Social and Health Determinants in Colorado: A Rapid Spatial Analysis. *Int J Environl Res Public Health* 2020; 17(11): 1-15.
26. Douglas M, Katikireddi SV, Taulbut M, McKee M, McCartney G. Mitigating the Wider Health Effects of covid-19 Pandemic Response. *BMJ* 2020; 369: 1-6.
27. Nicola M, Alsafi Z, Sohrabi C, Kerwan A, Al-Jabir A, Iosifidis C, Agha M, Agha R. The socio-economic implications of the coronavirus pandemic (COVID-19): A review. *Int J Surg* 2020; 78:185-193.
28. Ioannidis JPA. Coronavirus disease 2019: The harms of exaggerated information and non-evidence-based measures. *Eur J Clin Invest* 2020; 50: 1-5.

Table 1. Descriptive statistics of socioeconomic vulnerability indicators and COVID-19 outcomes in Brazilian states.

Variables	Mean (SD)	Median	Minimum	Maximum
Gini Coefficient	0.495(0.039)	0.495	0.398	0.548
Social Vulnerability Index	0.261(0.056)	0.258	0.134	0.374
COVID-19 cases†	697.48(510)	541.00	113	2353
COVID-19 deaths†	23.76(18.537)	19.76	1.44	63.31
Social Distancing Index	38.76 (2.68)	39.65	30.70	42.65

†per 100 thousand inhabitants

Table 2. Descriptive statistics of different Brazilian states groups according with degree of social vulnerability.

	Very low social vulnerability (n=4)	Low social vulnerability (n=18)	Moderate social vulnerability (n=5)
COVID-19 cases†			
Mean (SD)	329.2 (322.6)	693.7 (534.9)	1005.6 (376.6)
Median	198	523.5	968
Minimum	113	123	520
Maximum	808	2356	1488
COVID-19 deaths†			
Mean (SD)	7.6 (9.6)*	23.5 (18.1)	37.6 (16.3)*
Median	3.5	18.2	33.1
Minimum	1.4	2.8	23.2
Maximum	22	60.1	63.3
Social Distancing Index			
Mean (SD)	36 (4.2)	38.9 (2.1)	40.2 (1.6)
Median	36.2	39.1	40.1
Minimum	30.7	34.3	38.1
Maximum	40.1	42.9	42.6

†per 100 thousand inhabitants

*** Significant statistical differences between the groups (Kruskal-Wallis test and post-hoc Dunn test)**

306 **Table 3.** Correlation between socioeconomic disparities indicators measures and
307 COVID-19 outcomes in Brazilian states.

	Gini coefficient	Social Vulnerability Index
COVID-19 cases†	0.490*	0.504**
COVID-19 deaths†	0.356*	0.544**
Social Distancing Index	0.394*	0.520**

308 **Spearman's correlation test**

309 **†per 100 thousand inhabitants**

310 *** p≤0.05; ** p≤0.01**

311 **Table 4.** Multiple linear regression according to the Social Vulnerability Index.

Variables in the equation								
	F	df	R^2	β	t	95% Confidence Interval		p-value
						Lower bound	Upper bound	
COVID-19 cases†	5.031	1	0.168	0.409	2.243	46.387	280.860	0.034
COVID-19 deaths†	8.262	1	0.248	0.498	2.874	302.223	7091.379	0.008
Social Distancing Index	10.513	1	0.296	0.544	3.242	9.426	42.251	0.003

312 **†per 100 thousand inhabitants**