IMPACT OF SOCIOECONOMIC VULNERABILITY ON COVID-19 OUTCOMES AND SOCIAL DISTANCING IN BRAZIL

Paulo Cardoso Lins Filho [1]
Millena Mirella Silva de Araújo [2]
Andressa Kelly Alves Ferreira [3]
Maria Cecília Freire de Melo [4]
Thuanny Silva de Macêdo [5]
Jaciel Leandro de Melo Freitas [6]
Gustavo Pina Godoy [7]
Arnaldo de França Caldas Júnior [8]

ABSTRACT: Due to the persistently high cases and deaths, Brazil became one of the worst countries affected by the COVID-19 pandemic. Understanding the possible health inequities is essential, given the population's diversity and the country's fragile socioeconomic situation. Thus, this study aimed to assess the impact and correlation of socioeconomic vulnerability on COVID-19 outcomes and social distancing in Brazil. The Gini Coefficient (GC), the Social Vulnerability Index (SVI), epidemiological data on the 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. The mean values for the GC and SVI were 0.495 and 0.261, respectively. A positive statistically significant correlation was found between the socioeconomic indicators and the three variables related to the COVID-19 outbreak. 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. The COVID-19 outcomes and SDI in Brazilian states are correlated to socioeconomic conditions. The pandemic impacts are more severe on less favored communities.
KEYWORDS: COVID-19; Health Status Disparities; Social Determinants of Health; Pandemic; Economic Status.

[1] PhD Student in Dentistry.Universidade Federal de Pernanbuco (UFPE).
E-mail: paulocardoso09@hotmail.com
[2] PhD Student in Dentistry.Universidade Federal de Pernanbuco (UFPE).
E-mail: millenamirella@hotmail.com
[3] PhD Student in Dentistry.Universidade Federal de Pernanbuco (UFPE).
E-mail: andressaa.kelly@gmail.com
[4] PhD Student in Dentistry.Universidade Federal de Pernanbuco (UFPE).
E-mail: mceciliafreire@hotmail.com
[5] PhD Student in Dentistry.Universidade Federal de Pernanbuco (UFPE).
E-mail: thuannymacedo16@gmail.com
[6] Masters of Sciences in Dentistry. Universidade Federal de Pernanbuco (UFPE).
E-mail: jacielsanguiar@hotmail.com
[7] PhD in Oral Pathology. Universidade Federal de Pernanbuco (UFPE).
E-mail: gruiga@hotmail.com
[8] PhD in Public Health Dentistry. Universidade Federal de Pernanbuco (UFPE).
E-mail: arnaldo.caldas@ufpe.br

IMPACTO DA VULNERABILIDADE SOCIOECONÔMICA NOS RESULTADOS DA COVID-19 E NO DISTANCIAMENTO SOCIAL NO BRASIL

RESUMO: Devido ao número persistentemente alto de casos e mortes, o Brasil se tornou um dos países mais afetados pela pandemia da COVID-19. Compreender as possíveis desigualdades em saúde é essencial, dada a diversidade da população e a frágil situação socioeconômica do país. Assim, este estudo teve como objetivo avaliar o impacto e a correlação da vulnerabilidade socioeconômica sobre os resultados da COVID-19 e o distanciamento social no Brasil. O Coeficiente de Gini (CG), o Índice de Vulnerabilidade Social (IVS), os dados epidemiológicos sobre a epidemia de COVID-19 no Brasil e o Índice de Distanciamento Social (IDS) foram recuperados de bancos de dados on-line e avaliados para cada estado brasileiro. Os dados foram analisados estatisticamente por meio de testes não paramétricos e regressões lineares múltiplas. Os valores médios para o GC e o SVI foram 0,495 e 0,261, respectivamente. Foi encontrada uma correlação positiva estatisticamente significativa entre os indicadores socioeconômicos e as três variáveis relacionadas ao surto de COVID-19. Os estados com vulnerabilidade social muito baixa apresentaram menos mortes por 100 mil habitantes devido à COVID-19 do que os estados com vulnerabilidade social moderada. O IVS foi um preditor de casos acumulados, mortes confirmadas e distanciamento social. Os resultados da COVID-19 e o SDI nos estados brasileiros estão correlacionados às condições socioeconômicas. Os impactos da pandemia são mais graves nas comunidades menos favorecidas.

PALAVRAS-CHAVE: COVID-19; Disparidades no Estado de Saúde; Determinantes Sociais da Saúde; Pandemia; Situação Econômica.

IMPACTO DE LA VULNERABILIDAD SOCIOECONÓMICA EN LOS RESULTADOS DEL COVID-19 Y EL DISTANCIAMIENTO SOCIAL EN BRASIL

RESUMEN: Debido a la persistencia de un elevado número de casos y muertes, Brasil se convirtió en uno de los países más afectados por la pandemia de COVID-19. Comprender las posibles desigualdades sanitarias es esencial, dada la diversidad de la población y la frágil situación socioeconómica del país. Así, este estudio tuvo como objetivo evaluar el impacto y la correlación de la vulnerabilidad socioeconómica en los resultados del COVID-19 y el distanciamiento social en Brasil. El Coeficiente de Gini (CG), el Índice de Vulnerabilidad Social (IVS), datos epidemiológicos sobre la epidemia de COVID-19 en Brasil y el Índice de Distanciamiento Social (IDS) fueron recuperados de bases de datos en línea y evaluados para cada estado brasileño. Los datos se analizaron estadísticamente mediante pruebas no paramétricas y regresiones lineales múltiples. Los valores medios del CG y del IVS fueron 0,495 y 0,261, respectivamente. Se encontró una correlación estadísticamente significativa positiva entre los indicadores socioeconómicos y las tres variables relacionadas con el brote de COVID-19. Los estados con vulnerabilidad social muy baja presentaron una mayor vulnerabilidad social. Los estados con muy baja vulnerabilidad social presentaron menos muertes por cada 100 mil habitantes debidas al COVID-19 que los estados con vulnerabilidad social moderada. El IVS fue un predictor de casos acumulados, muertes confirmadas y distanciamiento social. Los resultados de la COVID-19 y el IVS en los estados brasileños están correlacionados con las condiciones socioeconómicas. Los impactos de la pandemia son más severos en las comunidades menos favorecidas.

1. INTRODUCTION

Less than four months after the first confirmed case of the 2019 novel coronavirus disease (COVID-19) in Brazil, the country reached the mark of more than one million accumulated cases, and over 50.000 confirmed deaths (BRAZIL, 2020). These numbers are estimated to be even greater, considering the likely occurrence of underreporting as the country was testing only severe cases (MARSON; ORTEGA, 2020). During the pandemic, the country faced a political crisis, misleading the efforts to mitigate COVID-19 spread and its socioeconomic impacts (ORTEGA; ORSINI, 2020; THE LANCET, 2020).

Brazil is the largest and most populous Latin-American country; its continental dimension favors diversity in socioeconomic and geographical aspects (KEHDY et al., 2015). 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 manage social issues, respecting each area's particularities (MARSON; ORTEGA, 2020).

All regions in Brazil have confirmed cases of COVID-19 (BRAZIL, 2020). There is a socioeconomic disparity among regions corroborating several issues related to 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 (ORTEGA; ORSINI, 2020; THE LANCET, 2020).

Despite denial of the pandemic in Brazil and 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 (BAMBRA et al., 2020; SOUZA FILHO et al., 2022). Special attention must be paid to vulnerable populations since recent reports indicate that incidence and deaths disproportionately affect less favored communities (DORN et al. 2020; DYER, 2020; TURNER-MUSA et al., 2020; DE NEGRI et al., 2021). 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 (WANG; TANG, 2020). Thus, the present study aims to assess the impact and correlation of socioeconomic vulnerability on COVID-19 outcomes and social distancing in Brazil.

2. MATERIALS AND 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 (BRAZIL, 2019) and the Institute of Applied Economic Research Statistics (BRAZIL, 2017), respectively. In addition to socioeconomic indicators, epidemiological data on the 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) (PABAYO et al., 2013).

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 (BRAZIL, 2015).

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 (BRAZIL, 2020).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 (INLOCO, 2020). Data is available on the Inloco website (https://mapabrasileirodacovid.in-loco.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.

3. 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 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.

Table 1. Descriptive statistics of socioeconomic vulnerability indicators and COVID-19 outcomesin Brazilian states, Recife, Brazil, 2020.

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

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.

Table 2. Descriptive statistics of different Brazilian state groups according with degree of social vulnerability, Recife, Brazil, 2020.

	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
Different superscript letter means statistically significant differences between groups
* Significant statistical differences between the groups (Kruskal-Wallis test and post-hoc Dunn test)

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).

Table 3. Correlation between socioeconomic disparities indicators measures and 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**

Spearman's correlation test
†per 100 thousand inhabitants
* $p \leq 0.05$; ** $p \leq 0.01$

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 (β = 0.409; t=2.243; p=0.034), confirmed deaths (β = 0.498; t=2.874; p=0.008), and social distancing index (β = 0.544; t=3.242; p=0.003). The values that describe these relationships are shown in table 4.

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

| | 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

Variables in the equation

per 100 thousand inhabitants

4. DISCUSSION

Health inequities are a worldwide issue (BAMBRA *et al.,* 2020). 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 (SMITH; JUDD, 2020; PEREIRA *et al.,* 2020). The findings of the present study support this statement since areas with different socioeconomic conditions were not 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 an increase in deaths (Table 4). These findings corroborate data from a cross-sectional study that showedthat less favored socio-racial groups with COVID-19 who were admitted to hospital had significantly higher risk of mortality (BAQUI *et al.,* 2020).

The impact of socioeconomic vulnerability on COVID-19 mortality is probably associated with the increasing comorbidity burden in regions with lower levels of socioeconomic development. Vulnerable communities are 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 (SANTOS *et al*., 2019), diabetes (MEINERS *et al*., 2017), cancer (BARBOSA *et al.,* 2015), asthma (CUNHA *et al*., 2007), and multiple comorbidities (CABRAL *et al*., 2019) were observed, those conditions represent an increased risk for severe COVID-19 health outcomes (GUAN *et al.*, 2020; XU *et al*., 2020; NETO, MARINHO, 2023). 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 (MARSON; ORTEGA, 2020).

Risk communication is an integral element of any public health emergency response (SHRIVASTAVA *et al*. 2016). However, vulnerable populations may not have the necessary language and literacy skills to understand and appropriately respond to pandemic messaging (SMITH; JUDD, 2020) because low health literacy is more prevalent among vulnerable populations (LYNCH; FRANKLIN, 2019). This may be associated with the difficulty in controlling 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 with social vulnerability (SOUZA FILHO *et al*., 2022). 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 (BAMBRA et al. 2020; RAMÍREZ; LEE, 2020).

Social distancing measures to control the spread of COVID-19 are likely to have large effects on health and health inequalities. 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 (DOUGLAS et al., 2020). 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 a 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, 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 (DOUGLAS et al.; NIKOLA et al., 2020). 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 preexisting socioeconomic disparities, deepening the problems of local health inequity in epidemic areas (WANG; TANG, 2020; IOANNIDIS et al., 2020).

Besides the immediate health effects for the vulnerable populations, the pandemic will certainly have long-term socioeconomic impacts on less favored communities (WANG; TANG, 2020). 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 (BAMBRA et al., 2020).

5. CONCLUSIONS

This study shows that the COVID-19 outcomes and SDI in Brazilian states are correlated to socioeconomic conditions, and the pandemic impacts are more severe on less favored communities.

One main limitation of this study is the use of online databases, which can involve lack of information and real-time update, and the relatively short study period, since the evidence found reflects the initial phase of the pandemic. Further studies of similar nature are encouraged to better understand the long-term repercussions of the COVID-19 pandemic on different socioeconomic population groups.

The present findings can be useful to health authorities apply to disease control efforts, guiding interventions and resource allocation to improve outcomes in vulnerable communities.

REFERENCES

BAMBRA *et al.*. The COVID-19 pandemic and health inequalities. **J. Epidemiol. Community Health**, v. 7411, p. 964–968, 2020.

BARBOSA, I. R. *et al*. Cancer mortality in Brazil: Temporal Trends and Predictions for the Year 2030. **Medicine**, v. 94, n. 16, 2015.

BAQUI, P. *et al*. Ethnic and regional variations in hospital mortality from COVID-19 in Brazil: a cross-sectional observational study. **Lancet Glob. Health.,** v. 8, 2020.

BRAZIL. Atlas of social vulnerability in Brazilian municipalities. Institute of Applied Economic Research, 2015.

BRAZIL. Atlas of Social Vulnerability. Institute of Applied Economic Research, 2017.

BRAZIL. Continuous National Household Sample Survey - Continuous PNAD. Brazilian Institute of Geography and Statistics (IBGE), 2019.

BRAZIL. Painel Coronavírus. Retrieved June 20, 2020, from: https://covid.saude.gov.br/.

CABRAL, J. F. *et al*. Vulnerability and Associated Factors Among Older People Using the Family Health Strategy. **Cien. Saude Colet.,** v. 24, p. 3227-3236, 2019.

CUNHA, S. S. *et al*. Ecological study of socio-economic indicators and prevalence of asthma in schoolchildren in urban Brazil. **BMC Public Health**, v. 7, 2007.

DE NEGRI, F. *et al.* Socioeconomic factors and the probability of death by Covid-19 in Brazil. **J. Public Health**, v. 43, n. 3, p. 493-498, 2021.

DORN, A. V.; COONEY, R.E.; SABIN, M. L. 2020. COVID-19 exacerbating inequalities in the US. **Lancet**, v. 395, p. 1243–1244.

DOUGLAS, M. *et al.* Mitigating the wider health effects of covid-19 pandemic response. **BMJ,** v. 369, 2020.

DYER O. Covid-19: Black people and other minorities are hardest hit in US. **BMJ**, v. 369, 2020.

GUAN, W. J. *et al.* 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**., v. 55, 2020.

INLOCO. Mapa brasileiro da COVID-19. Retrieved May 23, 2020, from: https://mapabrasileirodacovid.inloco.com.br/pt/.

IOANNIDIS, J. P. A. Coronavirus disease 2019: The harms of exaggerated information and non-evidence-based measures. **Eur J Clin Invest.**, v. 50, 2020.

KEHDY, F. S. G. *et al.* Brazilian EPIGEN Project Consortium. Origin and dynamics of admixture in Brazilians and its effect on the pattern of deleterious mutations. **Proc. Natl. Acad. Sci. USA,** v. 112, p. 8696–8701, 2015.

LYNCH, M.; FRANKLIN, G. Strategies to Reduce Hospital Mortality in Lower and Middle Income Countries (LMICs) and Resource-Limited Settings. London: IntechOpen, 2019.

MARSON, F.; ORTEGA, M. M. COVID-19 in Brazil. **Pulmonology**, v. 26, n. 4, p. 241–244, 2020.

MEINERS, M. M. M. A. *et al*. Access and adherence to medication among people with diabetes in Brazil: evidences from PNAUM. **Rev. bras. epidemiol.,** v. 20, p. 445-459, 2017.

NETO, F.R.G.X.; MARINHO, A. C. C. Construção e utilização de instrumento de estratificação de risco para vacinação de idosos contra a covid-19. **Arquivos de Ciências da Saúde da UNIPAR**, v.27, n.3, p.1346-1357, 2023.

NICOLA, M. *et al*. The socio-economic implications of the coronavirus pandemic (COVID-19): A review. **Int. J. Surg**., v. 78, p. 185–193, 2020.

ORTEGA, F.; ORSINI, M. Governing COVID-19 without government in Brazil: Ignorance, neoliberal authoritarianism, and the collapse of public health leadership. **Glob. public health**, v. 15, p. 1257–1277, 2020.

PABAYO, R. *et al*. Income inequality and mortality: results from a longitudinal study of older residents of São Paulo, Brazil. **Am. J. Public Health**, v. 103, p. e43–e49, 2013.
PEREIRA, F. A. C. *et al.* Profile of COVID-19 in Brazil—risk factors and socioeconomic vulnerability associated with disease outcome: retrospective analysis of population-based registers. **BMJ Global Health**, v. 7, n. 12, 2022.

RAMÍREZ, I. J.; LEE, J. COVID-19 Emergence and Social and Health Determinants in Colorado: A Rapid Spatial Analysis. **Int. J. Environ. Res. Public Health**, v. 17, n. 3856, 2020.

SANTOS D. *et al*. Prevalence of Systemic Arterial Hypertension in Quilombola Communities, State of Sergipe, Brazil. **Arq. Bras. Cardiol.**, v. 113, p. 383–390, 2019.

SMITH, J. A.; JUDD, J. COVID-19: Vulnerability and the power of privilege in a pandemic. **Health Promot. J. Austr.**, v. 31, p. 158–160, 2020.

SHRIVASTAVA, S. R.; SHRIVASTAVA, P. S.; RAMASAMY, J. Risk Communication: An Integral Element in Public Health Emergencies. **Int. J. Prev. Med**, v. 7, 2016.

SOUSA FILHO, J. F. *et al.* Association of urban inequality and income segregation with COVID-19 mortality in Brazil. **Plos one**, v. 17, n. 11, 2022.

THE LANCET. COVID-19 in Brazil: "So what?". **The Lancet,** v. 395, n. 1461, 2020.

TURNER-MUSA, J.; AJAYI, O.; KEMP, L. Examining Social Determinants of Health, Stigma, and COVID-19 Disparities. **Healthcare (Basel, Switzerland)**, v. 8, p. 168, 2020.

WANG, Z.; TANG, K. Combating COVID-19: health equity matters. **Nat Med.,** v. 26, n. 458, 2020.

XU, P. P. *et al*. Risk factors for adverse clinical outcomes with COVID-19 in China: a multicenter, retrospective, observational study. **Theranostics**, v. 10, p. 6372–6383, 2020.