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COVID-19 social vulnerability as a lethality conditioning factor

Vulnerabilidade social como condicionante da letalidade por COVID-19

La vulnerabilidad social a la COVID-19 como condicionante de la letalidad

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Abstract
Brazil presented different waves of contamination, registering different cases and numbers of deaths from COVID-19 depending on the region under study due to its continental size and territorial complexity, with 5,570 municipalities, 26 states, and one federal district. The focus of the study was to verify whether socioeconomic conditions have an influence on the pandemic and, if confirmed, to describe the mechanism and degree of influence. The study used a multivariate data analysis approach with a combination of exploratory factor analysis and hierarchical clustering techniques. The factor analysis resulted in the extraction of three factors with a characteristic root greater than one, which account for 94.23% of the total variation in the data, these being: basic assistance coverage; family assistance programs; basic education; and health care. In the cluster analysis, four differentiated groups were obtained from the factors listed. Among the main results, we highlight the fact that COVID-19 affected not only the health and epidemiological spheres in Brazil but also evidenced the existing social vulnerability, as well as generated impacts in different sectors.
Keywords: Factor analysis; Cluster analysis; Social vulnerability.

Resumo
Por sua dimensão continental e complexidade territorial com 5,570 municípios, 26 estados e um distrito federal, o Brasil, apresentou diferentes ondas de contaminação, registrando casos e número de óbitos da COVID-19 distintos depender da região em estudo .O foco do estudo foi verificar se as condições socioeconômicas possuem influência na pandemia e, se confirmado, descrever o mecanismo e grau de influência.O estudo utilizou uma abordagem de análise multivariada de dados com a combinação das técnica de análise fatorial exploratória e cluster hierárquico. A análise fatorial resultou na extração de três fatores com raiz característica superior a um, que respondem por 94,23% da variação total dos dados, sendo eles: Cobertura de assistência básica, Programas de assistência a famílias e educação básica e Assistência à saúde. Na análise de agrupamento, obteve-se quatro grupos diferenciados a partir dos fatores listados Dentre os principais resultados destacam-se o fato de a COVID-19 ter afetado não apenas o âmbito da saúde e epidemiológica no Brasil, mas evidenciou a vulnerabilidade social existente, assim como gerou impactos em diferentes setores.
Palavras-chave: Análise fatorial; Análise de cluster; Vulnerabilidade social.

Resumen
Debido a su dimensión continental y complejidad territorial con 5.570 municipios, 26 estados y un distrito federal, Brasil ha presentado diferentes olas de contaminación, registrando diferentes casos y número de muertes por COVID-19 según la región de estudio. fue verificar si las condiciones socioeconómicas tienen una influencia en la pandemia y, si se confirma, describir el mecanismo y el grado de influencia.El estudio utilizó un enfoque de análisis de datos multivariado con una combinación de análisis factorial exploratorio y análisis de conglomerados jerárquicos. El análisis factorial resultó en la extracción de tres factores con raíz característica mayor que uno, que explican el 94,23% de la variación total de los datos, a saber: Cobertura de la atención primaria; Programas de asistencia a la familia y asistencia en educación básica y salud. En el análisis de conglomerados, se obtuvieron cuatro grupos diferentes de los factores enumerados.Entre los principales resultados, destacamos el hecho de que COVID-19 no solo

ha afectado el ámbito sanitario y epidemiológico en Brasil, sino que también ha puesto de relieve la vulnerabilidad social existente. como impactos generados en diferentes sectores.
Palabras clave: Análisis factorial; Análisis de conglomerados;Vulnerabilidad social.

1. Introduction

The coronavirus (COVID-19) pandemic has social and economic effects, with 12 million infections and half a million deaths reported worldwide by July 2020 (Hopkins, 2021). (Lauer et al., 2020). Individuals who are affected by the virus present symptoms such as cough, fever, diarrhea, loss of smell and taste that can last for 14 days after exposure, varying in some cases from respiratory symptoms and others to life-threatening multiple organ failure (Fantozzin et al., 2020).

The pandemic of COVID-19 had its initial dissemination in large Brazilian cities (Burki, 2020; Lattin et al., 2011). Then, it spread to the peripheral regions of capitals and metropolitan regions, which are marked by poor housing conditions and social vulnerability (Chioro et al., 2020). According to Alburque et al. (2020), the COVID-19 pandemic can be analyzed as a geographic event whose duration varies between places, regions, and countries, presenting risks, vulnerabilities, and different responses to its confrontation.

In Brazil, a large part of the population is in a situation of vulnerability and excluded from basic rights (Mellan et al., 2020). Countries like Brazil, which have a large population and territorial size, states and municipalities have experienced different waves of contamination of the disease, recording different cases and numbers of deaths from COVID-19. As a result, studies that investigate whether COVID-19 affected municipalities in Brazilian cities equally have become indispensable in assisting in the face of the pandemic, being important for public policy organizations in general as well as the Unified Health System (SUS) (Costa et al., 2020).

In the pandemic, Brazilian states have challenges. There are no studies on how COVID-19 transmission influences populations living in precarious housing conditions, sanitation, no access to water and crowded situations (Werneck et al., 2020).

The COVID-19 pandemic brings a warning that studies and debates about the disease should go beyond descriptive analyses but contribute to strategies to fight infection, recognizing who the most vulnerable people to the disease are. (Nisida et al., 2020).

The pandemic as a social issue highlights the inequality existing in both rich and poor countries (Gonh, 2020), which are the most affected by this health crisis (Silva, 2021). The risk of infection is in more socially vulnerable groups, so the contamination is greater in people with low income due to the fact that these groups have to share, at the same time, dormitories, public transport, have less access to basic sanitation, or have difficulties in maintaining social isolation due to their characteristics of employment and income (Carvalho, 2020). The inequalities between the regions of the country affect the Human Development Index (HDI) because they are influenced by factors that have greater relevance, such as employment and social vulnerability (Mendes et al., 2020). In Table 1, we show some factors that are not related to health that were impacted by the COVID-19 pandemic.

Table 1: Factors that were affected by the COVID-19 pandemic.

Factors	Impact from COVID-19	Theoretical basis	Title
Economic	Positive	(Naidenova et al., 2020) (Atkeson, 2020) (Barro et al., 2020) (Mckibbin et al., 2020) (Baldwin et al., 2020) (Ali et al., 2020)	- Idiosyncratic and systematic shocks of pandemic COVID-19 on financial markets - The Global Macroeconomic Impacts of COVID-19: Seven Scenarios - Mitigating COVID's economic crisis: act fast and do what needs to be done - What will be the economic impact of COVID-19 in the US? Rough estimates of disease scenarios - Socio-economic Impact of the COVID-19 Pandemic: Evidence from the Rural Highland Community of Pakistan
Schooling	Positive	(Szwarcwald et al., 2020) (Silva, 2021)	- Adherence to contact-restriction measures and the spread of COVID-19 in Brazil - COVID-19 as a social issue: class, schooling, and color in the pandemic in Pará
Social Vulnerability	Positive	(Farias et al.,, 2020) (Leão et al., 2020)	- Social Vulnerability and COVID-19 - Social Abyss
Agribusiness	Positive	(Schineider et al., 2020)	- The effects of the COVID-19 pandemic on agribusiness and food
Employment and Income	Positive	(PNAD, 2020)	- Unemployment and Income in the pandemic
Tax Revenue	Positive	(Parapinski, 2021)	- Tax revenue behavior in the municipalities of the Triângulo Mineiro region against the COVID-19 pandemic
Cultural	Positive	(Barboza et al., 2020)	- COVID-19 and its socio-cultural impact: emotions, powers and new solidarity
Ethnic	Positive	(Dos santos et al., 2020) (Nisida et al., 2020)	- The black population and COVID-19: reflections on racism and health - Racism and the impacts of COVID-19 on the population of the city of São Paulo
Transportation	Positive	(Colombo, 2021)	- The Impact of the COVID-19 Pandemic on Public Transportation in the City of Cuiabá - Mato Grosso
Human Rights	Positive	(Morales et al., 2020)	- COVID-19 and Economic, Social, Cultural and Environmental Rights (DESCA): Impact of Inter-American Standards
Public Policies	Positive	(Abrucio et al., 2020) (Maity & Barlaskar, 2022)	- Combating COVID-19 under Bolsonarist federalism: a case of intergovernmental mismatch. - Political leadership and women's efficiency in reducing the COVID-19 mortality rate:an application of the technical inefficiency effects model in Indian states.
Feed	Positive	(Andrade et al., 2022) (Laila et al., 2021) (Amuakwa-Mensah et al., 2021)	- The impact of social welfare and COVID-19 stringency on the perceived usefulness of food apps:a hybrid MCDM approach. - Impact of COVID-19 on household food waste behavior: results of household waste composition audits. - Stock and eating concerns: changing habits and choices amid the COVID-19 pandemic
Socioeconomic	Positive	(Varkey et al. 2020)	- Socioeconomic determinants of COVID-19 in Asian countries: an empirical analysis

Source: Authors.

The number of deaths recorded influences the health system, the economy of the financial system and the population itself, also affecting the need for confinement and social distance, access to food and essential goods such as medicines and transportation (Fiocruz, 2021).

The crisis caused by the pandemic also had a direct impact on social and economic relations in all regions of the world affecting national economies. In 2020, Baldwin et al. (2020) discussed the economic impact of the COVID-19 pandemic and pointed out that the size of the economic damage was still uncertain.

For Andrade et al. (2022) the social welfare of the country and the successes in controlling Covid-19 had a negative impact on the use of food *delivery* apps and the pandemic changed people's eating habits. Laila et al. (2021) assessed the impact of COVID-19 on household food waste, as well as on perceptions and behaviors related to shopping, cooking, and food

waste. Amuakwa-Mensah et al. (2021) concluded that concerns about COVID-19's spread and economic impact may be changing consumer behavior in African countries. These results suggest that COVID-19 concerns may promote food stockpiling behavior generating waste.

The unemployed population in Brazil in 2020, which was 10.1 million in May, rose to 12.3 million in July of the same year, and in August it reached 12.9 million people, an increase of 27.6%. The unemployment rate during the COVID-19 pandemic increased by 0.5 percentage point from July to August, rising from 13.1% to 13.6%. People who were removed from work due to social withdrawal in the month of September, was 2.7 million, as well as people who did not look for work because of the pandemic, in the same period, was 15.3 million people (PNAD, 2020).

Given the above, this paper aims to investigate whether COVID-19 affected municipalities equally and whether socioeconomic conditions have an influence on the pandemic. **H_0**: The Brazilian municipalities analyzed have equal mean rates of COVID-19 cases and deaths. **H_1**: The Brazilian municipalities analyzed have different mean rates of COVID-19 cases and deaths.

2. Methodology

The operational analysis procedures were performed with the aid of Stata 16.0 software. Initially, an exploratory descriptive analysis was performed on the data referring to the study variables to verify the behavior referring to the distribution, frequency, and variability of the data.

The methodology is an integrative review, in which new concepts are proposed and makes it possible to identify research gaps whose theme of the present study was not widely discussed. As this is a quantitative Cross-Section research, we chose to combine different data analysis techniques such as factor analysis and cluster analysis.

The variables analyzed were obtained from the database of indicators of the IMRS (Mineiro Social Responsibility Index) provided for in Law 15011 of January 15, 2004, in which the construction was attributed to Fundação João Pinheiro. Data for the year 2019 were analyzed, being the most recent database on the platform.

The survey was conducted in the second half of 2021 and 17 study variables were selected (Table 3) after carrying out the exploratory data analysis, whose objective was to assess the consistency of the responses. For Triola (2005), when the research has a large dataset, exploratory data analysis is essential because it determines their quality.

2.1 Factor Analysis

In order to verify the hypothesis that COVID-19 affected the Brazilian municipalities differently, we analyzed the variables of cases of the disease and deaths recorded, for which we performed a factor analysis to isolate the initial variables. (Hair, 2009).

In this procedure, Bartlet's test of sphericity was applied to verify the correlation between the variables. The Kaiser-Meyer-Olkin (KMO) sample adequacy, which compares the magnitudes of the partial correlation coefficients, was also checked. Next, the principal components method was used to obtain factors and select the number needed to explain the data set. The determination of the number of factors extracted was based on the evaluation of the factors with eigenvalues higher than 1.0, the slope graph (*scree plot)*, and the accumulated percentage of variance extracted by the factors above 60%. The *varimax* procedure was used for factor rotation. Finally, the interpretation and nomination of factors were performed through the evaluation of the factorial matrix of rotated loadings, observing the highest loading for each variable of the factor.

2.2 *Cluster* Analysis

As a complementary procedure to factor analysis, a cluster analysis was performed to verify the formation of groups of socioeconomic variables and describe their characteristics following the steps of distance measure selection, choice of an agglomeration procedure, choice of the number of groups, their interpretation, and description of the groups. As a measure of similarity between the groups, the Euclidean distance between each pair of observations was used, such that smaller distances indicate greater similarity (Malhotra, 2006).

After the evaluation of the data and the dendogram, the groupings were chosen, named, and interpreted. A descriptive analysis of the goups formed was performed to analyze the characteristics and behavior of each group (Dancey et al., 2006).

This study was carried out with secondary data collected from the Secretary of State of Health, with epidemiological bulletins provided for the Brazilian municipalities (Secretaria de estado de saúde de minas, 2021).

2.3 Anova

The alternative study The hypothesis is that the COVID-19 pandemic affected the Brazilian municipalities differently. Given this, we used the statistical technique ANOVA, which is an analysis of variance to determine whether the means of three or more groups are different (Batista, 2021).

2.4 Minas Gerais State and COVID-19 cases

The state of Minas Gerais was chosen to represent Brazil due to its diversity, being the state with the largest number of municipalities and has a socioeconomic diversity, including great variation in vulnerability issues.

The state of Minas Gerais has an estimated population of 21,411,923 million inhabitants and a demographic density of 33.41 inhabitants/km2, with an HDI of 0.731. Located in the southeast region of the country, it has 853 municipalities divided into twelve geographical mesoregions, determined by the IBGE. The division of the territory of Minas Gerais, adopted by the state government, orders it in 12 Planning regions, can be seen in Table 2.

Table 2: Geographic mesoregions of the investigated state.

Regions	Number of Municipalities
Noroeste de Minas	19
Norte de Minas	89
Jequitinhonha	51
Vale do Mucuri	23
Triângulo Mineiro e Alto Paranaíba	66
Central Mineira	30
Metropolitana de Belo Horizonte	105
Vale do Rio Doce	102
Oeste de Minas	44
Sul e Sudeste de Minas	146
Campos das Vertentes	36
Zona da Mata	142

Source: Estado de minas gerais (2017).

In order to verify the distribution of cases of COVID-19 in the mesoregions of the state of Minas Gerais, a map was drawn, with the aid of the Data Studio tool, of the municipalities of Minas Gerais according to the number of registered cases of the disease. With the help of visual tools, we can verify the tendency of municipalities with larger populations to present higher numbers of cases of the disease.

3. Results and Discussion

3.1 Factor Analysis

The factor analysis allowed the extraction of three factors related to the social vulnerability of Brazilian municipalities (Ferreira & Braga, 2007; Ferreira et al., 2008). Table 3 shows the representation of the sets of variables used in the factor analysis.

Table 3: Variables used in the factor analysis.

Variable	Obs	Average	Maximum	Minimum	Standard Deviation
ppesf	853	94.84	100	16,13	12,37
psbf	853	23.13	70,34	3,12	12,82
psvuln	853	4.15	50,14	0	5,54
itgm	719	808	1	0	0,16
pri_ab	853	18835.58	1300000	733	57008,48
gpcs	853	807.90	4497	227,93	344,08
idhm2010	853	668	0,81	0,53	0,05
txps	853	1.86	48,46	0	3,72
txmed_ab	850	1.39	8,03	0	0,94
txesf	853	176,81	751,36	30.97	67,92
txest	853	1,05	7,2	0,2	0,6
escolar~2019	852	1,22	9,37	0	1,13
tx_edub2019	853	10,6	29,71	3,53	3,43
indiced~2019	853	89,66	100	44,46	9,37
valoricms	853	0,4	0,67	0,21	0,06
txlind	853	14300000	903000000	1454116	0
txmed_sus	853	11,18	66,42	3,54	4,64

Source: Authors.

The variables used present satisfactory adequacy represented by the result of the KMO test (Kaiser-Meyer-Olkin) of 0.6440 and the Bartlett's test, significant at 5% probability. For (Hair, 2009), in some cases in Social Sciences for less precise variables, values that are below 60% of the total variance are still considered satisfactory.

The factor analysis resulted in the extraction of three factors with characteristic roots (eigenvalues) greater than one (1) which together account for 94.23% of the total variance of the data, as shown in Table 4.

Table 4: Characterization of the main factors extracted by the principal components method.

Factor	Root characteristic	Explanatory variance by factor (%)	Accumulated variance (%)
F1	0.3239	1.88954	32.39
F2	0.3097	1.80703	63.36
F3	0.3087	1.80129	94.23

Source: Authors.

In function of the analysis of the factorial loadings corresponding to the correlation coefficients between variable i and factor j, after orthogonal rotation by the VARIMAX method (Table 5), it was possible to classify three factors relative to and define them according to their homogeneous representation as follows:

Table 5: Factorial matrix after VARIMAX orthogonal rotation.

Variable	Factor 1	Factor 2	Factor 3
pri_ab	0.8998		
valoricms	0.8472		
psbf		0.7852	
indiced~2019		-0.6367	
txmed_ab			0.6849
txest			0.6117
txmed_sus			0.7663
ppesf			
psvuln			
itgm			
gpcs			
idhm2010			
txps			
txesf			
escolar~2019			
tx_edub2019			
txlind			

Source: Authors.

Factor 1: Basic care coverage

Factor 1 corresponds to the grouping of the variables: Pri_ab (population with the highest priority for primary care coverage; estimate of the population with the highest priority for primary care coverage per municipal base (Resolution N1, of October 2, 2015); and ICMS (a non-cumulative tax levied on transactions regarding the circulation of goods and services rendered in interstate and intercity transport and communication). Under the competence of the States and the Federal District, as provided in art. 155, II, of the 1988 Constitution, it is one of the main sources of financial resources for the achievement of governmental actions. The general ICMS rules are contained in Complementary Law 87/1996, also known as the Kandir Law. In Minas Gerais, there is also Law 6763/1975 and the ICMS Regulation (RICMS), approved by Decree 4380/2002. (Secretaria do estado da fazenda de minas gerais, 2021).

Factor 2: Family assistance programs and basic education

Factor 2 corresponds to the grouping of variables: The proportion of the population served by the Family Health Strategy in which the ratio between the service capacity and the total population of the municipality is observed. The service capacity corresponds to the average number of teams per year and the estimated medical care per team. It is also possible to observe the percentage of people belonging to Bolsa Famlia beneficiary families, in which Bolsa Famlia is a program of the National Secretariat of Citizenship Income (Senarc) (Ministério da Cidadania, 2019), which contributes to the fight against poverty and inequality in Brazil, which has three main axes: income supplementation; access to rights; and articulation with other actions in order to stimulate the development of families (Ministério da Cidadania, 2019). And the Basic Education Index in 2019 (indiceb2019). This index brings together the results of two concepts for the quality of education: school flow and performance averages in assessments.

Factor 3: Health care

Factor 3 represents the combination of the variables txmed_ab (AB physicians), txest (number of CNES-contained health facilities), and txmed_sus (sus physician). This factor allows us to observe the number of doctors (Family Health Strategy doctors, Family and Community doctors, and pediatricians) who work directly in the SUS in relation to the population with the highest priority of care coverage. It can also be observed that the quantity of health establishments contained in the

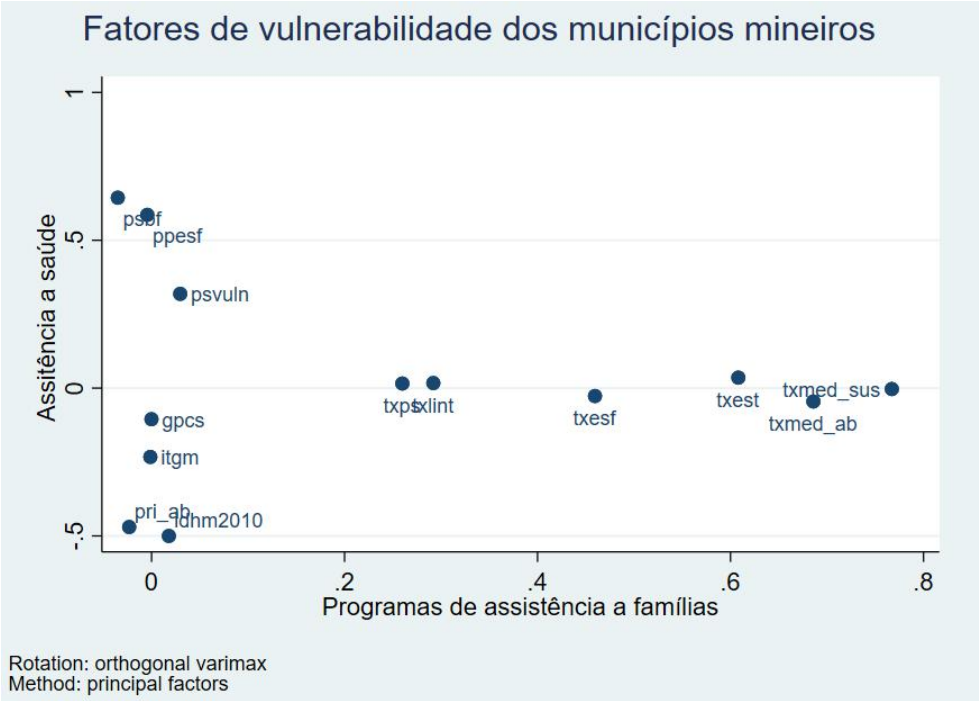
CNES (Ministério da saúde, 2019) by type, level of attention, service/classification, type of qualification, and types of care provided. And it measures the availability of doctors for care in the SUS according to geographical location.

3.2 Grouping of brazilian municipalities

The cluster analysis, or cluster analysis, was performed to complement the factor analysis, resulting in four differentiated groups: basic assistance coverage, health care and family assistance programs, and basic education. Based on the combination of factorial scores, the municipalities were classified into four groups based on the vulnerability factors of Brazilian municipalities.

Figure 1 shows the visualization of these groups in which it is possible to visualize the proposed analysis.

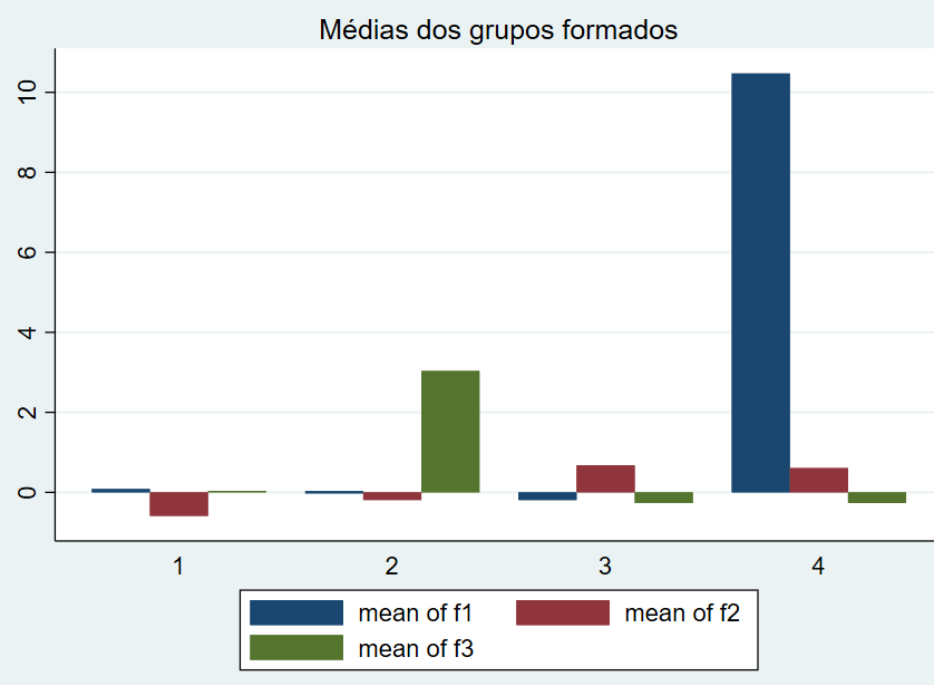
Figure 1: Vulnerability factor groups in Brazilian municipalities.



Source: Authors.

When analyzing the groups formed and the factors by the Bonferroni test, which evaluates the differences between the groups, all groups differ (p 0.05), which confirms that each group has characteristics that factor in relation to the vulnerability of the municipalities of Minas Gerais. In figure 2, we have the representation of the groups formed in relation to the average of the factors found in the factor analysis. Group 4 stands out, which has a higher average in relation to the other groups when comparing it with factor 1, Basic Care Coverage. Group 2 has a higher average in relation to factor 3 (health care).

Figure 2: Average of the groups formed in relation to the factors formed in the factor analysis.



Source: Authors.

The role of primary health care (PHC) in the health care network in Brazil can help address COVID-19 in the country by providing assistance to families, which the Family Health Strategy (FHS) model has attributes of territorial responsibility and community orientation to support populations in social isolation, such as monitoring mild cases in isolation, ensuring access to health care needed in severe cases, identifying vulnerable cases that must be followed up, as well as training health professionals (Fernandez et al., 2021; Dumas et al., 2020; Sarti et al., 2020; Fernandes et al., 2019).

Jamieson (2020) addresses preliminary lessons from New Zealand's response to COVID-19 that can be applied to all countries, such as the importance of effective risk communication, which ensures that people understand and trust the messages conveyed by a government that has prioritized keeping the public safe and the relative success of its efforts reflected on public health.

3.3 Anova

Table 6 shows the results found for the variables COVID-19 cases and deaths in the municipalities.

Table 6: ANOVA analysis for the COVID-19 Case and Death variable in the municipalities.

	DEATHS			CASES		
Population stratification	**Average**	**Standard Deviation**	**Frequency**	**Average**	**Standard Deviation**	**Frequency**
Very Large	348.7	262.97	33	32206	51573	33
Large	204.15	80.58	39	8264	3059	39
Medium	81.04	42.2	76	33180	148.81	76
Medium Regular	31.2	15.9	229	219.46	567.89	229
Small Regular	13.48	4.21	231	497.12	246.85	245
Very Small	6.5	4.21	231	279.6	137.52	231

Legend: Very Large: 100,001 to 10,000,000 inhabitants; Large: 50,001 to 100,000 inhabitants; Medium: 25,000 to 50,000 inhabitants; Medium Regular: 10,000 to 25,000 inhabitants; Small Regular: 5,000 to 10,000 inhabitants; Very Small: less than 5,000 inhabitants. Source: Authors.

To verify the relationship between population stratification and the number of cases (table 6) and number of deaths, we used the analysis of variance (ANOVA) to check for differences between the means of the COVID-19-related variables of involvement.

When analyzing the results of the analysis of variance by the Bonferroni test, which assesses the difference between groups, we safely rejected the Ho hypothesis. Prob > F was 0.000, so the Brazilian municipalities have different means of involvement in the variables of cases and deaths (p 0.05).

Qazi and Simsekler (2022) explore the dependencies between COVID-19 factors and country risks in a unified probabilistic network model to help decision makers understand the relative importance of individual factors that influence these risks. They analyzed hazard and exposure, vulnerability, and lack of coping capacity, while country risk factors are economic, financial, political, business environment, and trade risks. They found that business environment risks are significantly influenced by COVID-19 risk, as are financial, political, and economic risks, and business risk (demand disruptions) is the least important factor driving COVID-19 and country risk.

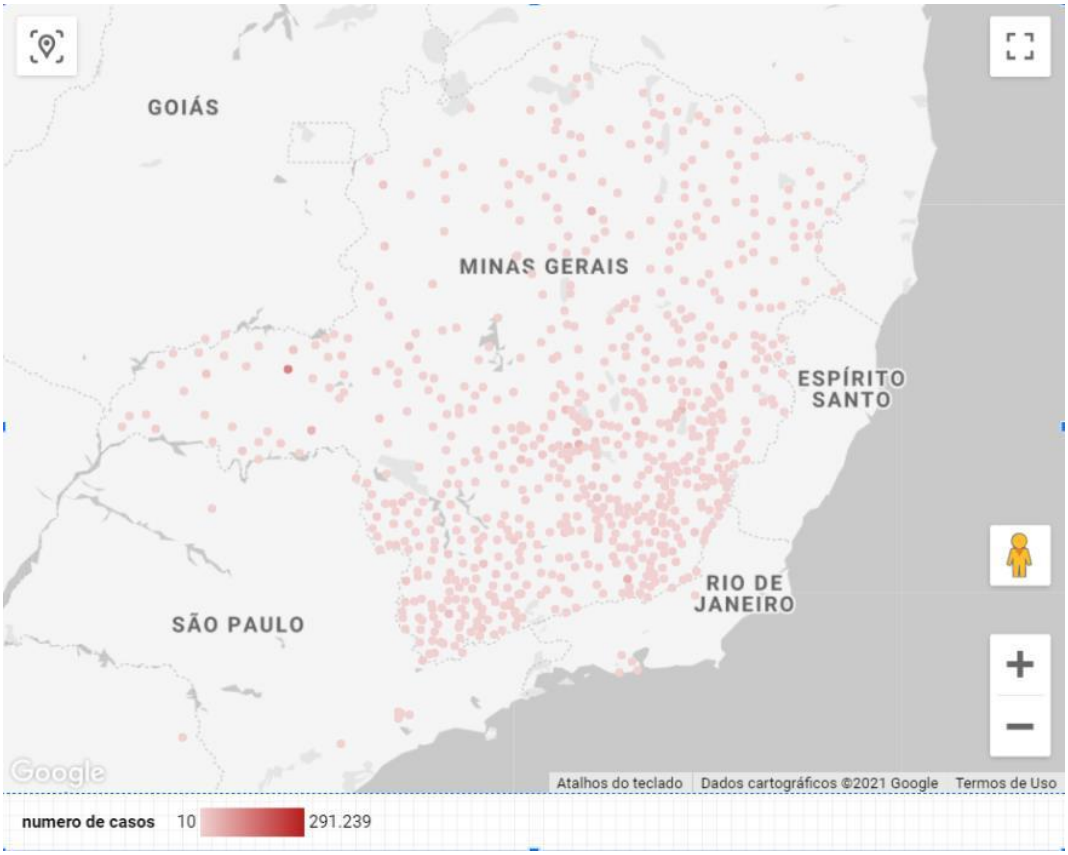
Some studies state that, besides the perspective that diseases are not only biological phenomena, they are also social in nature. For some populations, the pandemic had a greater impact, as is the case in slums, where social distance and the adoption of isolation and quarantine practices are impractical, both for reasons of population density and the economic impacts on a more vulnerable population (Fiocruz, 2021). Panarella e Tassinari (2022) prove that containment policies have a beneficial impact on the pandemic, managing to reduce the number of infections and deaths caused by COVID-19.

These needs are not causes of COVID-19, but they were aggravated by the pandemic. Leo et al. (2020) discovered that the lethality of COVID-19 is higher in poor neighborhoods than in higher social class neighborhoods because they lack basic sanitation and rely on the public health network.

Dos santos et al. (2020) state that social inequalities place populations in precarious health situations, presenting themselves in different ways according to location and social structure. Carvalho (2020), analyzed the education of infected Brazilians who had comorbidities correlated to COVID-19, and identified a significant increase among the less educated (54% with elementary school, and 34% with higher education); the number of ICU beds (Intensive Care Unit) in SUS is five times lower than in the private network, demonstrating that the social issue is interconnected with the pre-existing inequalities.

In Figure 3, represented by a map of the cities of Minas Gerais according to the number of registered cases of the disease, we have that in the state of Minas Gerais, by December 4, 2021, there had been 2,211,438 total confirmed cases and 56,309 confirmed deaths (Secretaria de estado de saúde de minas gerais, 2021).

Figure 3: Map prepared with the data of number of confirmed cases of COVID-19 and the population of each municipality.



Source: Authors.

Mendes et al. (2020) state that the measures to be taken regarding regional disparities in order to ensure human development require public policies that are decentralized and recognize the individual characteristics of each region of the country. From an analysis of the demand for the Consortium for the Development of the Rio Grande Valley (CODEVAR), it is clear that there are challenges in territorial planning to face the COVID-19 pandemic in Brazil.

Oliveira et al. (2017) conducted an analysis of the social vulnerability of the state of Minas Gerais' micro-regions and discovered that the mesoregions of Triângulo Mineiro/Alto Paranaba and Metropolitan Belo Horizonte have higher values in factors such as higher level of urbanization; population growth; and higher GDP. These factors provide some secondary factors, because they have household water service, garbage collection, and electricity. They also have better health service indicators. However, there are regions that have as characteristics a population with an income below the minimum wage and high rates of illiteracy. The mesoregions of the North of Minas, Jequitinhonha, and Vale do Mucuri stand out for their low level of schooling and unemployment.

It is noted that the mesoregions that are in greater social vulnerability also had higher numbers of COVID-19 cases. The regions with the highest concentration of COVID-19 cases are: Zona da Mata, Campo das Vertentes, South and Southwest of Minas, West of Minas, Vale do Rio Doce, Metropolitan Belo Horizonte, Vale do Mucuri, and Jequitinhonha. (Alexsander et al., 2021), also identified that the regions that had the highest number of cases in 2020 were Centro (30.92%), due to its location in the capital of Minas Gerais and its influence as an economic region, and the Northern Triangle (24.65%).

Mendes et al. (2020) analyzed the policies to combat COVID-19 in municipalities of Minas Gerais that adopted different restriction measures. As a result, the city of Ubá, located in the interior of the state of Minas Gerais, opted for a more flexible model with gradual variations. However, the city of Viçosa adopted more rigid measures to combat the disease, such

as restricting movement and access to the city. Although Ubá has registered the presence of the disease, the effort of the executive power minimized future problems due to the fragility of the health system of both cities and the lack of ICU beds.

It is evident the debate about the need for SUS infrastructure in preparation for COVID-19, both in planning and management, as ICU beds, respiratory, and hospital occupancy in the regions of the country due to regional heterogeneity and scarcity of resources. Without the influence of COVID-19, the number of ICU beds by SUS is less than adequate in 72% of the regions (Rache et al., 2020; Santos et al., 2021).

In view of the above, these data also make it possible to visualize the mesoregions that have greater social vulnerability and that have been more affected by the new coronavirus disease.

4. Conclusion

Given the results found, it was possible to verify that economic and social factors impact differently on the municipalities and mesoregions of the state of Minas Gerais in the face of the COVID-19 pandemic. According to some of the studies reviewed, the COVID-19 pandemic is not only a health issue but also a social issue, as it raises issues of coping with the pandemic in various ways in the most vulnerable municipalities.It was also possible, through this study, to create three factors: primary care coverage; health care; and family care programs.

In the future, a Socioeconomic Vulnerability Index of the municipalities in the state of Minas Gerais can be created based on COVID-19.

References

Abrucio, F. L. et al. (2020). Combate à COVID-19 sob o federalismo bolsonarista : um caso de descoordenação intergovernamental. *Revista de Administração Pública*, 54(4), 663–677. https://doi.org/10.1590/0034-761220200354

Ali, A., Ahme, M., & Hassan, N. (2020) Socioeconomic impact of COVID-19 pandemic: Evidence from rural mountain community in Pakistan. *Journal of Public Affairs*, e2355, 1–9. https://doi.org/10.1002/pa.2355

Alexsander, R. et al. (2021). Análise epidemiológica do COVID-19 no estado de Minas Gerais. *Revista de Atenção à Saúde*, 19, 237246. https//doi.org/10.13037/ras.vol19n68.7655

Albuquerque, M. V., & Ribeiro, L. H. L. (2020) Desigualdade, situação geográfica e sentidos da ação na pandemia da COVID-19 no Brasil. *Cadernos de Saúde Pública*, 36(12). 1–14. https://doi.org/10.1590/0102-311X00208720

Amuakwa. F. M, Mensah, S. A, Klege. R. A, & Adom. P. K. (2022). Preocupações com estoque e alimentação:mudança de hábitos e escolhas em meio à pandemia de Covid-19. *Ciências do Planejamento Sócio-Econômico*. 82, Parte A,101181, https://doi.org/10.1016/j.seps.2021.101181 .

Andrade. L, H. Antunes. J, J, M., Medeiros, A. M. A, Wanke, P, & Nunes, B. P. (2022). O impacto do bem-estar social e do rigor do Covid-19 na utilidade percebida dos aplicativos de alimentos: uma abordagem MCDM híbrida. *Ciências do Planejamento Sócio-Econômico*.v.82,101299, 10.1016/j.seps.2022.101299

Atkeson, A. (2020). What Will Be the Economic Impact of Covid-19 in the Us? Rough Estimates of Disease Scenarios.p-1-27, *National Bureau of Economic Research*, doi:10.3386/w26867.

Baldwin, R., & Mauro, B. W. (2020). Mitigating the COVID Economic Crisis: Act Fast and Do Whatever It Takes. *Centre for Economic Policy Research*, London, EC1V 0DX

Barboza Tello, M. L. F., & Doreen, M. (2020). El COVID-19 y su impacto socio cultural: emociones, poderes y nuevas solidaridades. Documentos de Trabajo (IELAT, Instituto Universitario de Investigación en Estudios Latinoamericanos), Impreso y hecho en España ,Printed and made in Spain

Barro, R. J., Ursua, J. F., & Weng, J. (2020). Coronavirus meets the Great Influenza Pandemic.*National Bureau Of Economic Research*.Retrieved november 23, 2021,from https://www.hks.harvard.edu/centers/mrcbg/programs/growthpolicy/coronavirus-meets-great-influenza-pandemic

Batista, L. A. V. O índice de confiança empresarial e o ciclo de vida das organizações: um estudo nas Micro e Pequenas Empresas no contexto do Covid-19. http://repositorio.ufersa.edu.br/handle/prefix/6480

Burki, T. COVID-19 in Latin America. (2020). *The Lancet. Infectious diseases*, 20(5), 547–548. https://doi.org/10.1016/S1473-3099(20)30303-0

Carvalho, L. (2021) Curto-circuito: O vírus e a volta do Estado.*Monções: Revista de Relações Internacionais da UFGD* 10(20), 596-600, https://doi.org/10.30612/rmufgd.v10i20.13747

Chioro, A. et al. (2020). Covid-19 em uma Região Metropolitana: vulnerabilidade social e políticas públicas em contextos de desigualdades. *Saúde em Debate*, 44, 219–231. 10.1590/0103-11042020E414

Colombo, S. (2021). the Impact of the Covid-19 Pandemic on Public Transportation in the City of Cuiabá - Mato Grosso. *Brazilian Journal of Development*, 7(3), 29244–29246. 10.34117/bjdv7n5-636

Costa, A. M., Rizzotto, M. L. F., & Lobato, L. De V. C. (2020). Na pandemia da Covid-19, o Brasil enxerga o SUS. *Saúde em Debate*, 44(125), 289–296. 10.1590/0103-1104202012500

Daumas, R. P. et al. (2020). O papel da atenção primária na rede de atenção à saúde no Brasil: limites e possibilidades no enfrentamento da COVID-19. *Cadernos de Saúde Pública*, 36(6), 1–7. https://doi.org/10.1590/0102-311X00104120

Dancey, C. P. et al. (2006). Teste de Hipóteses e Significância Estatística. *Estatística sem Matemática para Psicológia*, Armed.

Dos santos, M. P. A. et al. (2020). População negra e Covid-19: Reflexões sobre racismo e saúde. *Estudos Avancados*, 34(99), 225–244. https://doi.org/10.1590/s0103-4014.2020.3499.014

Estado de minas gerais. (2017). Macrorregião Oeste. *Mortalidade por neoplasia em Minas Gerais*, http://mg.gov.br/sites/default/files/paginas/arquivos/2016/ligminas_10_2_04_listamesomicro.pdf

Fantozzi, P. J. et al. (2020). Xerostomia, gustatory and olfactory dysfunctions in patients with COVID-19. *American Journal of Otolaryngology - Head and Neck Medicine and Surgery*, 41(6), 1–5.10.1016/j.amjoto.2020.102721

Fernandes, G. C. M. et al. (2019). Atenção primária à saúde em situações de desastres: revisão sistemática. *Revista Panamericana de Salud Pública*, 43, 1–8. https://doi.org/10.26633/RPSP.2019.76

Fernandez, M., Lotta, G., & Corrêa, M. (2021). Desafios para a Atenção Primária à Saúde no Brasil: uma análise do trabalho das agentes comunitárias de saúde durante a pandemia de Covid-19. *Trabalho, Educação e Saúde*, 19, 1–20. https://doi.org/10.1590/1981-7746-sol00321

Farias, M. N., & Junior, J. D. L. (2020). Vulnerabilidade social e COVID-19: considerações a partir da terapia ocupacional social. *Cadernos Brasileiros de Terapia Ocupacional*, 1(1), 15. https://doi.org/10.1590/2526-8910.ctoEN2099

Ferreira, M. A. M, & Braga, M. J. (2007). Desempenho das cooperativas na indústria de laticínios do Brasil: uma abordagem por grupos estratégicos. Revista de Administração-RAUSP, 42(3), 302-312. https://www.redalyc.org/articulo.oa?id=223417438004

Ferreira, M. A. A., Abrantes, L, & Perez, R. (2008). Investigação de grupos estratégicos na indústria de laticínios por meio da abordagem multivariada. RAM. *Revista de Administração Mackenzie*, 9, 152-172. https://doi.org/10.1590/S1678-69712008000200008

Fiocruz. (2021). Covid-19 Favelas: Fiocruz aponta que Pandemia tem mais Impacto em Áreas Pobres do Rio. https://www.epsjv.fiocruz.br/podcast/covid-19-favelas-fiocruz-aponta-que-pandemia-tem-mais-impacto-em-areas-pobres-do-rio

Guimarães, R. B., Simon, C. R., & Lima, J. P. P. C. de. (2020). Covid-19, regiões de saúde e os desafios do planejamento territorial no Brasil. *Revista Brasileira de Geografia Médica e da Saúde*, 370–379. https://doi.org/10.14393/Hygeia0054640

Gonh, M. G. (2020). Educação Não Formal: Direitos e Aprendizagens Dos Cidadãos (Ãs) Em Tempos Do Coronavírus . *Revista Humanidades e Inovação*, Palmas:UNITINS

Hair. JR. M. (2009) Análise multivariada de dados. Dados eletrônicos. Bookman

Jamieson, T. (2020). "Go Hard, Go Early": Preliminary Lessons From New Zealand's Response to COVID-19. American *Review of Public Administration*, 50(6–7), 598–605, 10.1177/0275074020941721

Hopkins. J. (2021). COVID-19 *Dashboard do Center for Systems Science and Engineering (CSSE)*. https://coronavirus.jhu.edu/map.html

Laila. A, Massow. M. V, Parizeau. K, & Haines. J. (2021). Impacto do Covid-19 no comportamento de desperdício de alimentos das famílias:resultados de auditorias de composição de resíduos domésticos.*Ciências do Planejamento Sócio-Econômico* 82, Parte A, 101188. https://doi.org/10.1016/j.seps.2021.101188

Lattin, J., Carroll, D., & Green, P. E (2011). Análise De Dados Multivariados. Cengage Learning

Lauer, S. A. et al. (2020). The incubation period of coronavirus disease 2019 (CoVID-19) from publicly reported confirmed cases: Estimation and application. *Annals of Internal Medicine*, 172(9), 577–582. 10.7326/M20-0504

Leão, A. L. et al. (2020). Abismo Social. http://www.fsp.usp.br/site/wp-content/uploads/2020/01/G2T4I5P2M.1.screen-1-1.pdf

Maity, S, & Barlaskar, U, R. Li. (2022). Liderança política e eficiência das mulheres na redução da taxa de mortalidade por Covid-19:uma aplicação do modelo de efeitos de ineficiência técnica nos estados indianos. *Ciências do Planejamento Sócio-Econômico, 82, Parte B,*101263, doi:10.1016/j.seps.2022.101263

Malhotra, N. (2006). *Análise De Agrupamentos.* Bookman

Mckibbin, W. J., & Fernando, R. (2020). The Global Macroeconomic Impacts of COVID-19: Seven Scenarios. *SSRN Electronic Journal*, 1–43. http://dx.doi.org/10.2139/ssrn.3547729

Mendes, W. A., Ferreira, M. A. M., Faria, E R., & Arantes, L A. (2020). Desenvolvimento humano e desigualdades regionais nos municípios brasileiros. *Latin American Research Review*, 55, 742-758. http://doi.org/10.25222/larr.555

Mendes, W. de A. et al. (2020). Políticas de combate à Covid-19 em municípios mineiros. *Research, Society and Development*, 9(8), 1–18. https://doi.org/10.33448/rsd-v9i8.5080

Medina, M. G. et al. (2020). Atenção primária à saúde em tempos de COVID-19: o que fazer? *Cadernos de Saúde Pública*, 36(8), 1–5. 10.1590/0102-311X00149720

Mellan, T. A. et al. (2020). Estimating COVID-19 cases and reproduction number in Brazil. *Imperial College London.* doi.org/10.25561/78872.

Ministério da Cidadania. (2021). Bolsa Família. https://www.gov.br/cidadania/pt-br/acoes-e-programas/bolsa-familia

Ministério da Cidadania. (2021). Secretaria Nacional de Renda de Cidadania. https://www.gov.br/cidadania/pt-br/composicao/desenvolvimento-social/senarc

Ministério da Saúde. (2021). Cadastro Nacional de Estabelecimentos de Saúde. http://tabnet.datasus.gov.br/cgi/cnes/NT_Estabelecimentos.htm

Morales A, M., Piovesan, F., & Rossi I, R. (2020). Covid-19 e direitos econômicos, sociais, culturais e ambientais (DESCA): impacto dos estandares interamericanos. *Revista de Direito Econômico e Socioambiental*, 11(1), 59. 10.7213/rev.dir.econ.soc.v11i1.27353

Naidenova, I., Parshakov, P., & Shakina, E. (2020). Idiosyncratic and Systematic Shocks of COVID-19 Pandemic on Financial Markets. *SSRN: Electronic Journal*. http://dx.doi.org/10.2139/ssrn.3574774

Nascimento, B. F. et al. (2021). Perfil Epidemiológico da Pandemia por Covid-19 no Estado de Minas Gerais. *The Brazilian Journal of Infectious Diseases*, 25, 101142. https://doi.org/10.1016/j.bjid.2020.101142

Nisida, V. C., & Cavalcante, L. A. (2020). Racismo e impactos da COVID-19 na população da cidade de São Paulo. *Revista Brasileira de Direito Urbanístico*, 10, 151–172. 10.55663/rbdu.v6i10.80

Oliveira, L. P., da costa, E. P. V. da S. M., & Filho, V. R. (2017). Social Vulnerability Analysis By Microregions in the State of Minas Gerais, Brazil. *Geo UERJ*, 30, 58–75. 10.12957/geouerj.2017.29321

Parapinski, A. E. D. O. (2021). Comportamento da Arrecadação Tributária nos municípios do triangulo mineiro frente a pandemia do Covid-19. https://repositorio.ufu.br/bitstream/123456789/33132/1/ComportamentoDaArrecada%c3%a7%c3%a3o.pdf

PNAD, I. B. DE G. E E. (2021). Desemprego na pandemia.Retrieved december 8, 2021, from https://agenciabrasil.ebc.com.br/economia/noticia/2020-09/desemprego-subiu-276-em-quatro-meses-de-pandemia

Panarello. D, & Tassinari. G. (2022). Um ano de Covid-19 na Itália:as políticas de contenção são suficientes para moldar o padrão da pandemia? *Ciências do Planejamento Sócio-Econômico*. 79, 101120.https://doi.org/10.1016/j.seps.2021.101120

Qazi, A, & Simsekler, M. C. E. (2022). Nexus between drives of Covid-19 and country risks. *Ciências do Planejamento Sócio-Econômico*., 101276. https://doi.org/10.1016/j.seps.2022.101276

Rache, B. et al. (2020). Necessidades de Infraestrutura do SUS em Preparo ao COVID19: Leitos de UTI, Respiradores e Ocupação Hospitalar. *Instituto para Estudo em Políticas de Saúde* - Nota técnica 3. http://www.epsjv.fiocruz.br/sites/default/files/files/NT3 vFinal.pdf

Sarti, T. D. et al. (2020). Qual o papel da Atenção Primária à Saúde diante da pandemia provocada pela COVID-19? *Epidemiol. Serv. Saude*, 29(2), 1–5. 10.5123/S1679-49742020000200024

Santos, R. J. M. (2021). Consórcios Públicos de saúde em tempos de pandemia da Covid-19. Brasilia-DF: In: Planejamento e Gestão. Brasília: Conselho Nacional de Secretários de Saúde

Schneider, S. et al. (2020). Os efeitos da pandemia da Covid-19 sobre o agronegócio e a alimentação. *Estudos Avançados*, 34(100), 167–188. 10.1590/s0103-4014.2020.34100.011

Secretaria de estado de saúde de minas gerais. (2021). Boletim Epidemiológico Covid-19. 8, 2021, https://coronavirus.saude.mg.gov.br/painel

Secretaria de estado de fazenda de minas gerais. (2021). ICMS-Minas Gerais. http://www.fazenda.mg.gov.br/empresas/impostos/icms/

Silva, V. V. A. D. A. (2021). a Covid-19 enquanto questão social: classe, escolaridade e cor da pandemia no Pará. *HOLOS*, 1, 1–14. https://doi.org/10.15628/holos.2021.11519

Szwarcwald, C. L. et al. (2020). Adesão às medidas de restrição de contato físico e disseminação da COVID-19 no Brasil. *Epidemiologia e Serv. Saúde: revista do Sistema Unico de Saude do Brasi*l, 29(5), e2020432. http://dx.doi.org/10.1590/s1679-49742020000500018

Triola, M. F. Introdução à estatística. LTC

Varkey, R. S. et al. (2020). Socioeconomic determinants of COVID-19 in Asian countries: An empirical analysis. *Journal of Public Affairs*, e2532, 1–10. https://doi.org/10.1002/pa.2532

Werneck, G. L., & Carvalho, M. S. (2020). A pandemia de COVID-19 no Brasil: Crônica de uma crise sanitária anunciada. *Cadernos de Saúde Publica*, 36(5), 1–4. https://doi.org/10.1590/0102-311X00068820