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Social distancing and living conditions in the pandemic COVID-19 in Salvador-Bahia, Brazil

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Abstract *In the current scenario of the COVID-19 pandemic, Brazilian states and municipalities have adopted social distancing measures as a strategy to reduce the number of cases and control the disease. These measures affect populations and territories differently. This study aims to analyze the trend of social distancing in this pandemic and its relationship with the context of living conditions in Salvador, Bahia, Brazil. An ecological study with spatial distribution was conducted. The municipality's Social Distancing Index and the Living Conditions Index were calculated. Global and Local Moran Indices were employed to assess the degree of spatial dependence and autocorrelation. Fluctuations were observed in the social distancing levels during the analyzed period, with higher distancing percentages in neighborhoods with more favorable living conditions. The analysis and interpretation of COVID-19 containment measures, such as social distancing, should consider the profile of local vulnerability of each territory for the correct dimensioning of pandemic mitigation strategies from the perspective of developing social actions enabling greater adherence of the most impoverished populations.*

Key words *Social distancing, Inequalities, Socioeconomic factors, Vulnerability study, Coronavirus infections*

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Introduction

Social distancing is a non-pharmacological strategy covering case isolation, contact quarantine, and the voluntary avoidance of crowded environments[1], which has shown some effectiveness in controlling the exponential growth of the disease. This strategy can protect health systems from collapse due to a much higher demand than supply, especially when it comes to ICU beds[2]. On the other hand, the social and economic impacts and determinants are discussed as limiting factors of this strategy, generating discussions about the duration of these restrictive measures[3].

As a result of the spread of the SARS-Cov-2 virus worldwide and following actions taken in other countries that have successfully controlled the pandemic, several Brazilian states and municipalities have adopted social distancing measures to reduce human contact, and consequently, control the speed of virus transmission. Among these measures are the cancellation of public events, closing schools and businesses, and recommendations for people to stay home, among others[4].

The diversity of the socioeconomic and human development context at the regional level was one of the reasons that stimulated the creation of a Scientific Committee of the Northeast region, consisting of researchers of national reference, to propose and articulate strategies to combat and mitigate the COVID-19 pandemic. Among the set of actions linked to this committee are initiatives to monitor the epidemic curves of each state and social distancing to reduce the demand for hospital admissions and the number of deaths.

One way of observing the effectiveness of social distancing is through the Social Distancing Index (SDI). While distancing theoretically consists of separating sick people from those who are not infected[4], this index was developed by firm Inloco to calculate the population respecting the distancing recommendations, here understood as social distancing measures. Inloco is a startup in the technology industry that has followed the movement of approximately 60 million Brazilians through the geolocation of smartphones[5].

In Brazil, the highest SDI was recorded on March 22, 2020 (62.2%), and on June 9, the country had an SDI of 38.2%. In the Northeast region, all states had indexes below 60% in the same period. The reduction of contacts above this percentage can reduce the transmission of the disease when associated with containment measures (isolation, contact quarantine)[4]. In Bahia, the index reached 45.7% on May 26, and is the fifth-best in Brazil. The Bahian capital, in turn, has the third-best index among all the capitals of the country, second only to Macapá and Recife, respectively[5,6].

While the Bahian capital has a reasonable distancing rate compared to other Brazilian capitals, a higher number of cases and deaths have been observed, revealing the continuing upward trend of the disease[7]. Understanding that economic and environmental factors directly interfere when people can remain socially distant during the pandemic[8], it is essential to evaluate how social distancing is distributed among the different neighborhoods of the Bahian capital, relating it to people's living conditions. Thus, this study aims to analyze the trend of social distancing adopted to control the COVID-19 pandemic and its relationship with living conditions in Salvador.

Methods

An ecological study of spatial aggregates was carried out in Salvador, Bahia, from March 23 to April 27, 2020. The capital has an estimated population in 2019 of 2,872,347 inhabitants, with an area equivalent to 693,453 km² and a demographic density of 3,859.44 inhabitants/km² [9].

The research analyzed social distancing and aspects related to the living conditions between neighborhoods in the municipality. The evaluation of this non-pharmacological measure was based on the calculation of the SDI, which used the smartphone data provided by Inloco (records of 1 million geolocalized smartphones)[5]. The data were obtained considering the smartphone movements observed when they occurred outside a radius of 400 meters from the individuals' homes. The SDI was made available by Inloco in an aggregated form in the space unit in hexagons and then was made compatible in the neighborhood unit.

The Urban Health Index (UHI) was considered as a proxy for living conditions (LC). This index allows a flexible approach to data selection, grouping, and presentation, aiming to provide health inequalities graphically, visually, and statistically[10]. The UHI comprises seven sociodemographic indicators, calculated from data from the 2010 Brazilian demographic census: 1- Proportion of residents with per capita monthly household income of up to half minimum wage; 2- Proportion of black people; 3- Illiteracy rate (proportion of people aged 15 and over who are

illiterate); 4- Schooling rate (proportion of people with 15 and more years of study); 5- Proportion of households connected to the regular water supply network; 6- Proportion of households with regular garbage collection; 7- Household density (average number of people per household)[10]. These indicators received a score, which, when added together, resulted in a score for each neighborhood regarding the Living Conditions Index (LCI). Lower LCI scores corresponded to the worst living conditions[10].

Bearing in mind that part of the Brazilian population and the capital of Bahia are in a context of social vulnerability, it was also necessary to analyze the vulnerability indicators. These measure structural aspects of a given population group, human development conditions, and the capacity to respond to a health problem. The Votorantim Institute developed the Municipal Vulnerability Index (MVI) to identify the degree of vulnerability of each Brazilian municipality compared to the impacts caused by the COVID-19 pandemic[11]. The MVI uses secondary public data obtained from official sources and consists of dimensions with different composition weights, namely: vulnerable population (32.35%), local economy (11.76%), health services' structure (23.53%), health system organization (20.59%), and administrative capacity (11.76%). The final score ranges from 0 to 100 points and indicates that the higher the MVI value of a given municipality, the more vulnerable it is to the impacts of COVID-19[11].

The Global and Local Moran Indices were calculated to analyze the degree of spatial dependence between neighborhoods concerning the SDI. These indices range from 0 to 1, and the higher its value, the more spatially dependent they are.

The QGIS software version 2.18 (Environmental Systems Research Institute - ESRI, Redlands, CA, United States) was used to build thematic maps. The Global and Local autocorrelation calculations were performed using Geoda software version 2.14. R and Excel 2016 software was used to manage the bases and other analyses.

Results

SDI fluctuations are observed during the period analyzed in the municipality of Salvador. On March 17, 2020, SDI was 26.0%, reaching the highest percentage on April 22 (67.0%). Values varied since then, reaching 50.1%, on April 27. This indicator grew irregularly, with a mean of 22.5% between February 2 and March 16, 2020, and 51.4% after that period (March 17 to April 27, Figure 1).

When analyzing the spatial analysis of SDI, from March 23 to April 27, 2020, between neighborhoods in the municipality studied, we observed an irregular distribution of adherence to social distancing measures (Figure 2). The best SDI adherence neighborhoods were Stella Maris, Graça, Vitória, Barra, Garcia, and Pituba, with a mean of 57.0%. In contrast, the neighborhoods Jardim Cajazeiras, Jardim Santo Inácio, Pau da Lima, São Marcos, Arenoso, and Sussuarana had the lowest occurrence of SDI, with a mean record of 48.0% in the analyzed period.

The Global and Local Moran Index analysis revealed a high correlation (a significant Global Moran's I index of 0.676) in the areas with the highest adherence and low correlation in the neighborhoods with the least adherence to distancing (Figure 3). The highest distancing percentages were concentrated in neighborhoods with more favorable living conditions, especially those located on the seafront of the city of Salvador (Figure 4).

The analysis of the MVI in Salvador points to a global score of 47.7. The dimensions assessed by the MVI indicate that the municipality has a score of 45.7 for a population vulnerable to the effects of COVID-19, highlighting the percentage of the elderly population with 12.0%; the population registered in the Single Registry (26.9%) and the number of hospitalizations for comorbidities associated with the development of severe cases of COVID-19 per thousand inhabitants[8,9]. The dimension with the highest score was the local economy with 65.8. This index reveals a GDP per capita of R$ 21,231.48, with 29.4% of the employed population and a mean income of 3.4 monthly minimum wages for formal workers.

The health system structure received approximately 46.0 points, consisting of the number of hospital beds (24.6/10 thousand inhabitants), number of ICU beds (25.4/100 thousand inhabitants), and number of fans and respirators (44.7/100 thousand inhabitants) in the micro-region. In the organization of health services, the score was 54.0, considering that 71.8% of the population is dependent on the public health system, with 37.9% referring to PHC coverage. The municipality's best score was in the administrative capacity, with a value of 27.8.

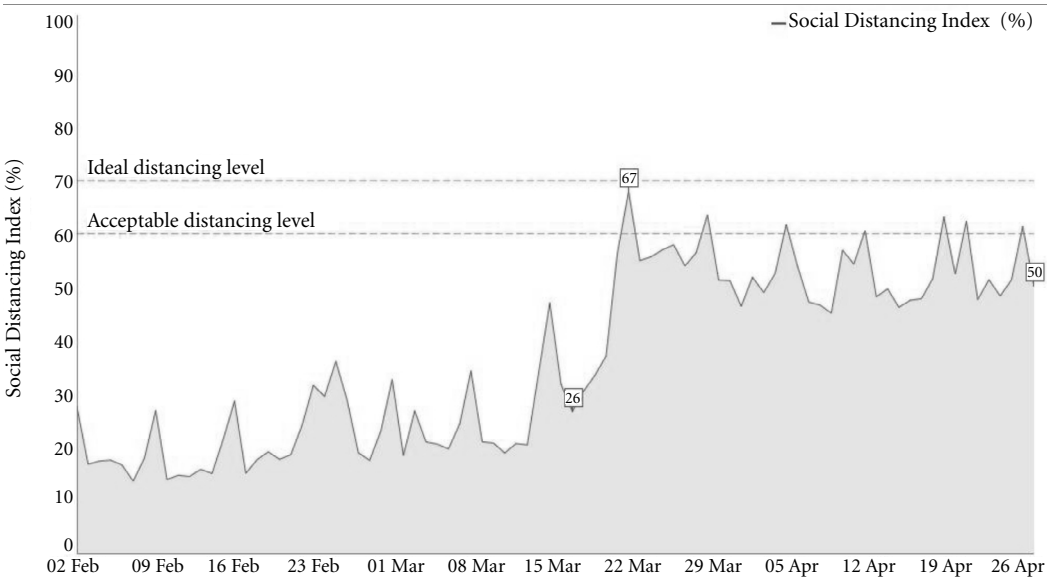

Figure 1. Time trend of the Social Distancing Index in the city of Salvador (BA), Brazil, from 02/02/2020 to 27/04/2020.

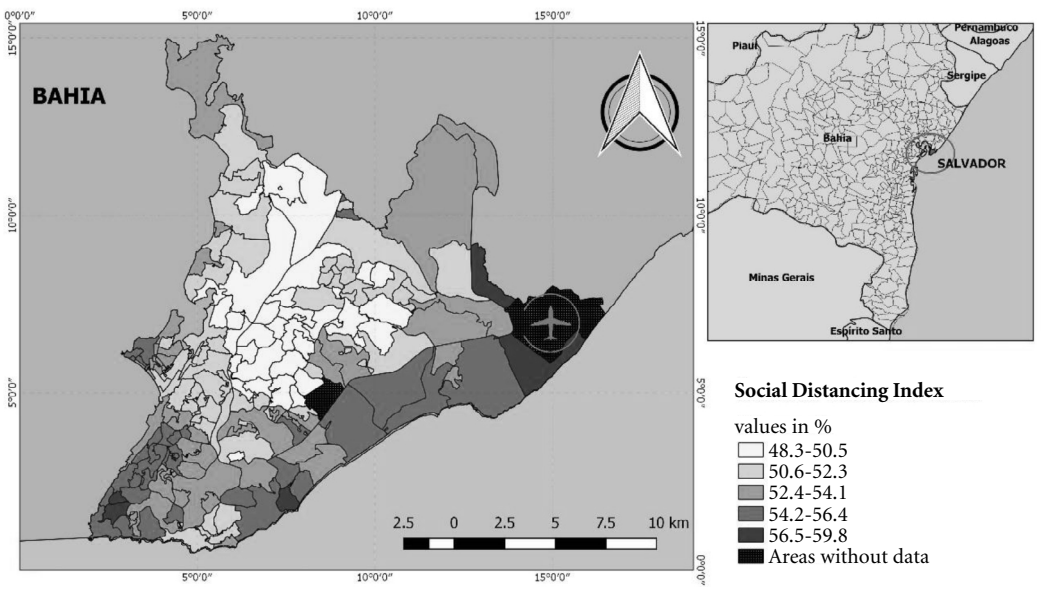

Figure 2. Spatial distribution of the Social Distancing Index in the city of Salvador (BA), Brazil, from 23/03/20 to 27/04/20.

Discussion

This study points to a possible relationship between social isolation and living conditions in Salvador-Bahia. The neighborhoods considered to have the highest poverty rate[12] are those with the lowest percentage of SDI.

Furthermore, the municipality has a high vulnerability index, which places it at a disadvantage in facing the pandemic, when compared to other

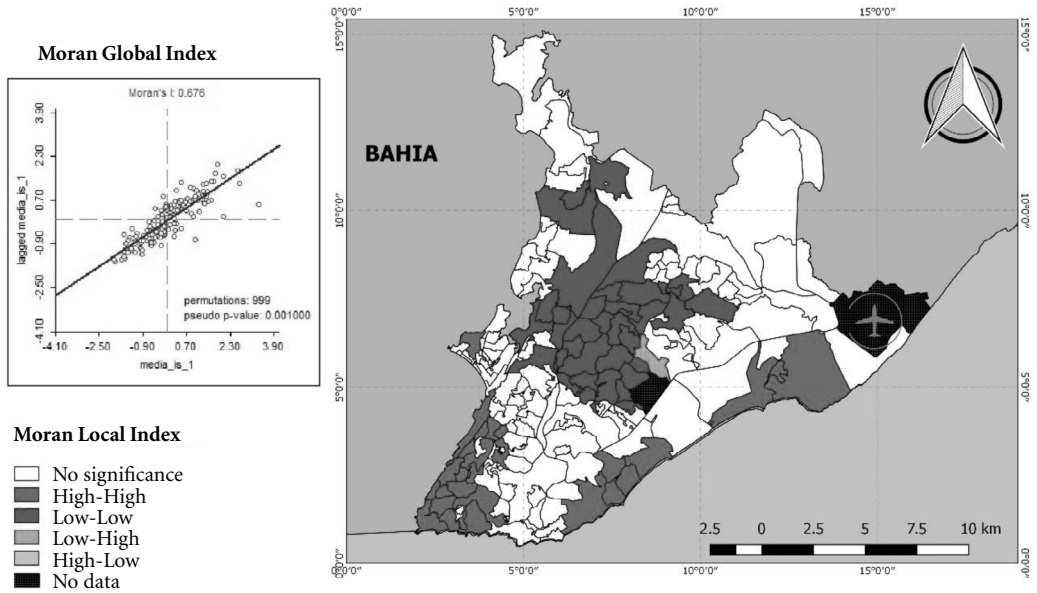

Figure 3. Spatial autocorrelation pattern of the Social Distancing Index in neighborhoods in the city of Salvador (BA), Brazil, from 23/03/20 to 27/04/20.

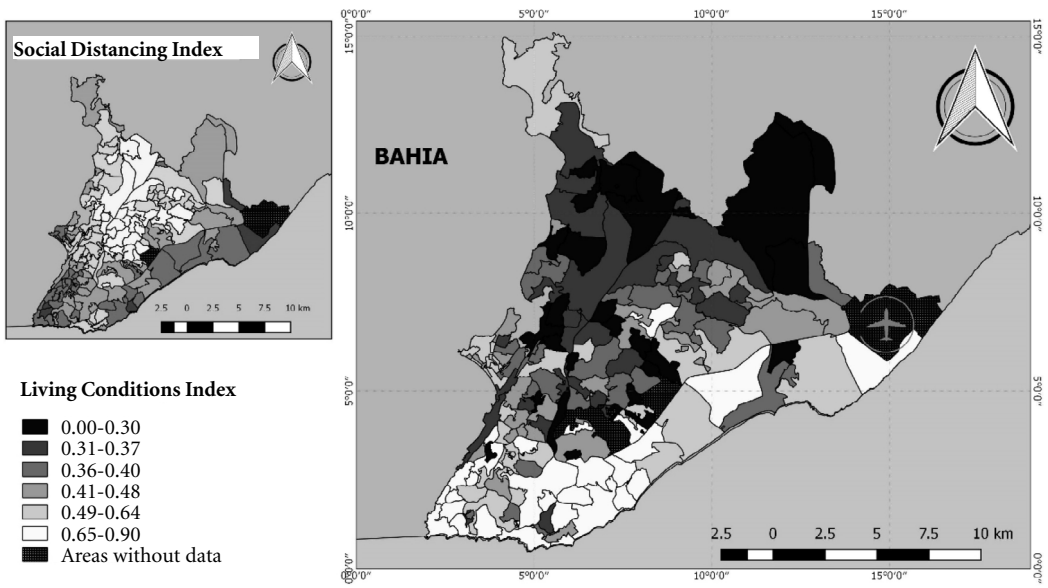

Figure 4. Spatial distribution of Living Conditions in neighborhoods in the municipality of Salvador (BA), Brazil, from 23/03/20 to 27/04/20.

Brazilian capitals, such as São Paulo (global score 41.2) represented in specific dimensions of the vulnerable population with a score of 55.4, local economy aspects (34.5), the structure of health services (40.1), organization of health services with the best score 26.1, and municipal administration capacity (39.9). Another municipality used as a reference was Curitiba (global score of 45.9), consisting of vulnerable population scores of 50.3, the local economy of 34.6, structure and

organization of health services with scores of 46.5, and 42.5, respectively, and administrative capacity, with a score of 45.9[11].

The results point to a picture of significant social inequalities and concentration of income, revealing that the Bahian capital remains segregated by different social conditions. The upper- and middle-income strata are concentrated in the central area or on the seafront, while the lower-income groups gather mainly in peripheral areas or on the borders with the surrounding municipalities[13].

Low adherence to social distancing measures can be determined by social inequality because the distribution of health and disease in populations is not random, and is associated with social status, which in turn defines the people's living and working conditions[14]. On the other hand, social distancing can be influenced by cultural aspects, characteristics of political and health systems and operational procedures to implement pandemic mitigation strategies[4].

In this context, some factors may be associated with people's behavior during social distancing. Aspects related to occupation and fear of unemployment are issues to be considered. Essential portions of the population that survive informal work find it difficult to adhere to distancing, as they need to supplement their income, although they are on a temporary income transfer program[3,8,15]. Furthermore, the informal work context limits the conditions for protecting workers, with greater exposure to risks and the need to maintain informal activity as a means of survival. The quality of information, government officials' credibility, and uncertainty about the virus also affect adherence. How public health authorities report on the importance of distancing can bring higher or lower confidence in the measure[8,15].

It should also be noted that people with lower income are more exposed to the financial impacts caused by the COVID-19 pandemic and more vulnerable to being affected by physical and psychological health problems associated with the seclusion required during the social distancing period[8,15]. Such conditions of vulnerability can be more damaging in communities formed by families living in a single domestic room, as the possibility of COVID-19 infection may be greater[3,8,15]. Therefore, the challenges surrounding effective measures to promote social distancing should be overcome.

Given this scenario of inequities in the city of Salvador and the importance of non-pharmacological measures to reduce the number of COVID-19 cases, the only disease control strategy in the absence of specific therapy or vaccines[16], it is necessary to warn about the need to stimulate and create real conditions, through emergency public policies, in order to increase people's adherence to social distancing, especially in areas with greater inequality. The exponential progression of the epidemic is inexorable, and health services will collapse[17] without significant social distancing or a combination of moderate social distancing combined with the active search for cases to proceed with the necessary distancing.

The isolation of cases and contacts associated with social distancing decreases the incidence of the disease and has a considerable economic impact. Wang et al.[18] revealed a positive impact from an economic viewpoint when analyzing the Chinese context. Distancing and quarantine were the most economical interventions, avoiding 1,696 cases, and saving around US$ 11,515 on health expenditure[18].

Although non-pharmacological strategies have positive impacts, especially concerning the ability to save lives[19], an economic collapse is also a significant risk for the development of health problems. Eventually, the pandemic will affect everyone economically, and a global recession is imminent[20]. Containing the spread and reducing the pandemic's economic impact will require coordinated actions between the economy and health sectors to mitigate the problems arising from these two crises[21].

For example, adherence to distancing also depends on social protection measures that secure resources for the economically most impoverished population. In Brazil, the emergency aid provided for in Law No. 13.982/2020, modified with a new wording under PL 873/2020, extends the emergency aid of R$ 600.00 to more categories of people in vulnerable conditions, is considered insufficient. According to information available on the Senate's website, more than 96 million have already requested this emergency aid, and 50.5 million people were considered eligible, which evidenced the significant portion of the Brazilian population living in impoverished conditions[22].

In short, the living conditions of considerable portions of the population of Salvador impose clear limitations on social distancing and the adoption of hygiene measures, identified by health organizations as essential to avoid infection by the virus, given that this city is the capital of a state located in one of the poorest regions of the country. The difficulties inherent to their

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living situation require additional governmental measures to ensure minimum hygiene, health, and well-being standards. Low-income people residing in suburban areas or slums are subject to a series of risks and threats to their survival (access to food and minimum hygiene and health standards), and higher risk to physical and psychological integrity, with emphasis on women who are mostly exposed to violence and overload of domestic work[23].

Despite the limitation inherent in this study, since smartphone data may have originated mostly from high-income people, the findings reveal that the analysis of containment measures such as social distancing should not be done in isolation and should consider the profile of local vulnerability for the correct measurement of prevention and control strategies. The planning of the municipality must, therefore, be based on the epidemiological scenario, considering the differences and inequities between different neighborhoods, recommending the implementation/maintenance of social protection policies, and the development of actions that contribute to the maintenance of jobs and workers' income, giving priority to the most vulnerable groups. It is imperative to establish financial support, to be distributed in an agile and unbureaucratic way by the different federated entities to guarantee income for informal workers, mothers, and household heads, among others.

Finally, it should be noted that while social distancing in the analyzed municipality and its respective neighborhoods has not achieved the desired values, it remains one of the most critical COVID-19 control and prevention measures. Due to the number of confirmed cases, deaths, beds, and tests, extreme social inequities, and a percentage of adherence to social distancing below ideal levels in the Bahian capital, we understand that this is not the moment to relax since much still needs to be developed to reduce the transmission and production of cases and, therefore, control this pandemic. Additional methodological approaches are required to broaden the understanding of the repercussions of living conditions and social distancing in the occurrence and severity of COVID-19 in the population.

Collaborations

MS Natividade designed the study, collected and analyzed data, and wrote the paper. K Bernardes, M Pereira, Samilly Miranda, and E Aragão contributed to the paper's writing and review. J Bertoldo and H Livramento contributed to data analysis and critical review of the paper. MG Teixeira carried out a critical review of the study. All authors approved the final version of the study.

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