DOI: 10.1590/1980-549720190032

ORIGINAL ARTICLE / *ARTIGO ORIGINAL*

Spatial analysis of AIDS and the social determinants of health

Análise espacial da AIDS e os determinantes sociais de saúde

Simone de Sousa Paiva[I], Nathália Lima Pedrosa[II], Marli Teresinha Gimeniz Galvão[II]

ABSTRACT: ***Introduction:*** The social determinants of health (SDH) are factors that can influence the distribution of rates for acquired immunodeficiency syndrome (AIDS) in a given region. The objective of this study was to analyze SDHs related to AIDS. ***Method:*** Ecological study, using spatial analyses techniques. 7,896 disease case reports were analyzed over a period of 11 years. Subjects were 13 years or older and residents of the state of Ceará, in the northeast of Brazil. The area of analysis was the municipality, calculating both the average rate of AIDS and the Freeman-Tukey transformed average rate for measuring softening. We used the Simple Linear Regression Model to make the spatial correlation between AIDS detection rates and SDH. A Geographic Information Systems (GIS) was used to manipulate georeferenced data. ***Results:*** High rates of AIDS could be found in cities with better living conditions. Additionally, there was a significant relationship between primary health care coverage and lower rates of the disease in Ceará. ***Conclusion:*** Socioeconomic indicators with statistically significant correlation to the distribution of AIDS should be targeted by strategies policies in the fight against the disease.

Keywords: Spatial analysis. Acquired Immunodeficiency Syndrome. Social determinants of health.

[I]Escuela de Enfermería, Universidad de Santiago de Chile – Santiago, Chile.
[II]Departamento de Enfermagem, Universidade Federal do Ceará – Fortaleza (CE), Brasil.
Corresponding author: Simone de Sousa Paiva. Rua Alexandre Baraúna, 1.115, Rodolfo Teófilo, CEP: 60430-160, Fortaleza, CE, Brazil. E-mail: simonesh.paiva@gmail.com
Conflict of interests: nothing to declare – **Financial support:** none.

RESUMO: ***Introdução:*** Os determinantes sociais de saúde (DSS) podem influenciar na distribuição das taxas da síndrome da imunodeficiência adquirida (AIDS) de uma região. Este trabalho teve o objetivo de analisar os DSS que se relacionam com a AIDS. ***Método:*** Estudo ecológico com técnicas de análise espacial. Analisaram-se 7.896 notificações dos casos da doença em um período de 11 anos, cujos indivíduos possuíam idade igual ou superior a 13 anos e eram residentes no Estado do Ceará, Região Nordeste do Brasil. A unidade de análise foi o município, calculando-se a taxa média de AIDS e a taxa média transformada de Freeman-Tukey para a suavização das medidas. Foi feita correlação espacial das taxas de detecção de AIDS com os determinantes sociais de saúde, utilizando-se o modelo de regressão linear simples. Empregaram-se os sistemas de informações geográficas (SIG) para manuseio dos dados georreferenciados. ***Resultados:*** Altas taxas de AIDS foram encontradas em municípios que apresentaram melhores condições de vida. Observou-se relação significativa entre cobertura da atenção primária em saúde e baixas taxas da doença no Ceará. ***Conclusão:*** Os indicadores socioeconômicos com correlação estatisticamente significativa com a distribuição da AIDS devem servir de base para políticas de combate à doença.

Palavras-chave: Análise espacial. Síndrome da imunodeficiência adquirida. Determinantes sociais de saúde.

INTRODUCTION

Over 30 years ago, a deadly disease that would initially affect men, homosexuals, young and healthy people emerged. At that time, one could not imagine how much AIDS would provoke discussion of complex issues such as human rights and social issues[1].

Although the overall increase in the distribution of antiretroviral therapy (ART) contributed to the 48% decline in AIDS-related deaths[2] in Brazil, more than 880,000 cases of the disease were detected in the country from 1980 to June 2017, with an annual average of 40,000 new cases and a gradual fall in the detection rates of the disease in recent years. However, this is not the case in the Northeast of the country, where there was a linear trend of growth in AIDS detection rates, with an increase of 35.7% between 2006 and 2016[3].

In this context, it is plausible to affirm that socioeconomic inequalities can lead to inequalities in health. In some countries, the mortality of the general population varies according to the socioeconomic situation of the localities. With regard to AIDS, late diagnosis can occur in economically disadvantaged regions[4], leading to an increase in opportunistic diseases and early deaths.

There are many variables related to the health/disease process, including social and economic status, education, employment, housing and physical and environmental exposure. These factors affect health and may influence the increase in morbidity rates. Studying the social determinants of health (DSS) is important, especially in countries characterized by large economic and health disparities, such as Brazil, and it is possible to introduce public policies that integrate health, social and economic actions[5].

Stigma, discrimination and homophobia are examples of conditions that increase the chances of developing diseases[6].

There is, therefore, a need to address SDH in order to achieve equitable health outcomes[7]. Responsibility for social indicators that affect AIDS rates calls for a diversified workforce, whose actions are focused on broad access to quality health care, with resources for all populations[8]. Also, understanding the relationship between the health behaviors adopted by individuals and the characteristics of the places where they live is essential for the understanding of SDH[9].

The relevance of the study is related to the need to know the main SDH for AIDS in Ceará, with a 42% increase in disease detection rates in the state from 2006 to 2015[10]. Despite the great efforts of the government, current prevention measures require considering the socioeconomic reality that interferes with the health/disease process of AIDS, in order to make effective its actions to control the epidemic in the region.

In view of the above, the study aimed to analyze SDHs that are related to AIDS.

METHOD

An ecological study was carried out, and the unit of analysis was the municipality. Spatial analysis techniques were used and geographic information systems (GIS) were used as data manipulation tools.

Located in the Northeastern Region of Brazil, the state of Ceará is divided into 184 municipalities and has an approximate area of 148,886.3 km^2. The estimated population in 2015 was 8.9 million inhabitants, with a human development index (HDI) of 0.682[11].

The study included all individuals aged 13 years old or older (age range used in the definition of AIDS cases in adults, for reporting purposes), living in Ceará and reported with AIDS in the period from 2001 to 2011, totaling 7,896 notifications.

The AIDS notification forms of the Disease Notification System (*Sistema de Informação de Agravos de Notificação* – SINAN) were used, whose information was provided by the Health Department of the state of Ceará (SESA).

The socioeconomic variables of Ceará were obtained from the last Demographic Census available in the country, conducted in 2010 by the Brazilian Institute of Geography and Statistics (IBGE). Data were transformed into rates and proportions and their values, aggregated by municipality. Unemployment rate, Gini index (used to calculate inequality of income distribution), coverage of the Family Health Strategy (FHS) service and coverage by the Community Health Agents Program (*Programa de Agentes Comunitários de Saúde* – PACS) were information provided by the Department of Informatics of the Unified Health System — SUS (DATASUS) — and by the Department of Primary Care. The collinearity between the socioeconomic variables was evaluated by the calculation of the variance inflation factor (VIF).

The mean AIDS detection rate for the period and the municipality was calculated from the sum of the rates calculated per year divided by the number of years studied, using the population data available on the IBGE website as the denominator. The Freeman-Tukey (FT) transformed rate was calculated in order to reduce the variations of detection rates with very small values and to allow the identification of spatial patterns[12]. This rate was considered as a dependent variable and used for correlation with SDH.

The Pearson test was used to verify the statistical correlation between the dependent variable (AIDS detection rate) and covariates (socioeconomic indicators). The Shapiro-Wilk test was used to measure the normality of the dependent variable. For all of the study's tests, alpha below 0.05 was considered necessary for rejection of the null hypothesis, being this the independence of the values of AIDS rates in relation to the socioeconomic indicators of the region.

For the creation of thematic maps, a shapefile type vectorial cartographic base was obtained from the IBGE website, containing polygons that delimit the political divisions of Ceará by municipality. The neighborhood matrix employed was the contiguity criterion.

The Moran index was used to verify the spatial correlation between neighboring areas and the Jarque-Bera index to test the normality hypothesis of the residues.

Spatial analysis was performed using the global spatial regression method, the simple linear regression model (SLRM). The model allows us to identify whether the explanatory variables tested remain associated with the response variable, considering the influence of socioeconomic and demographic factors on their spatial distribution.

The residuals generated by the MRLS modeling were analyzed, which should be free of spatial autocorrelation, not presenting clusters. The absence of spatial autocorrelation in the model residuals reveals a random spatial pattern for the specified model, indicating good modeling fit.

We used the SPSS 20.0 and ArcGis 10.1 softwares in this research.

The study is part of a broad investigation, entitled "Spatial distribution and social determinants of health in the population with AIDS in Ceará", approved by the Research Ethics Committee of SESA, with a favorable opinion (approval number of the Research Ethics Committee: 203.911, CAAE number: 08928612.6.0000.5051). Guidelines for research involving human beings, regulated by Resolution No. 196/96 and restated by Resolution No. 446/11, were respected.

RESULTS

CHARACTERIZATION OF THE STUDIED POPULATION

In Ceará, there was a progressive increase of the disease in the studied population, which went from 7.69 cases per 100,000 inhabitants in 2001 to 14.14 cases per 100,000 inhabitants in 2011. Most of the cases were detected in the male population — corresponding to almost 67% of total notifications — of brown coloration (80%) and in the age range of 30 to 39 years. The highest detection rates were concentrated in the capital of Ceará (Fortaleza) and its surroundings.

PEARSON'S CORRELATION

The bivariate analysis showed a significant association between AIDS rates and the majority of social indicators (Table 1), except for Gini index, unemployment rate and proportions of owned households, households without sanitary sewage, households with open sewage, and semi-adequate and inadequate households ($p > 0.05$).

The coverage by FHS and PACS (r-Pearson = -0.17 and -0.21, respectively) presented an inversely proportional relation (p = 0.0240 and 0.005, respectively), that is, municipalities with high coverage of primary care had lower disease rates.

Also, according to the bivariate analysis, most of the socioeconomic indicators that indicate the better living conditions of the studied population showed a direct and significant relationship with the values of AIDS rates, especially income averages (r-Pearson = 0.37 and p = 0.000),

Table 1. Pearson's correlation coefficient between transformed rate of AIDS and socioeconomic indicators. Ceará, Brazil, 2001–2011*.

Socioeconomic indicators	Freeman-Tukey AIDS rate	
	r-Pearson	p-value
Population covered by FHS	-0.17	0.0240
Population covered by PACS	-0.21	0.0050
Unemployment rate	0.04	0.5485
Gini Index	-0.13	0.0691
Average *per capita* income	0.37	0.0000
Proportion of poor people	-0.44	0.0000
Proportion of owned households	-0.04	0.5452
Proportion of rented households	0.26	0.0004
Proportion of households with water connected to the general network	0.17	0.0239
Proportion of households without water not connected to the general network	-0.16	0.0264
Proportion of households with sanitary sewage	0.20	0.0056
Proportion of households without sanitary sewage	-0.01	0.9266
Proportion of households with open sewage	-0.08	0.2770
Proportion of households without a restroom	-0.32	0.0000
Proportion of households with more than three restrooms	0.36	0.0000
Proportion of illiterate people in charge	-0.46	0.0000
Proportion of females in charge of the household	0.27	0.0002
Proportion of males in charge of the household	-0.25	0.0006
Proportion of adequate households	0.19	0.0086
Proportion of semi-adequate households	0.07	0.3133
Proportion of inadequate households	0.06	0.4511

*Data referring to the survey carried out in 2014.
FHS: Family Health Strategy; PACS: Community Health Agents Program.

the proportions of households with water connected to the general network (r-Pearson = 0.17 and p = 0.0239), households with sanitary sewage (r-Pearson = 0.20 and p = 0.0056), households with more than three restrooms (r-Pearson = 0.36 and p = 0.000), adequate households (r-Pearson = 0.19 and p = 0.0086) and the proportion of female respondents (r-Pearson = 0.27 and p = 0.0002). We also identified a direct and statistically significant relationship between the response variable and the proportion of rented households (r-Pearson = 0.26 and p = 0.004).

SPATIAL CORRELATION

The spatial correlation of the socioeconomic indicators, obtained by the Moran index (Table 2), showed the spatial dependence of the great majority of the variables ($p < 0.05$), especially indicators related to income, households with three or more restrooms and households with an illiterate person in charge (Moran index > 0.3).

The bivariate analysis of the transformed AIDS rate and socioeconomic indicators, also using the Moran index, showed a positive value and statistical association of the following indicators: proportion of households in the poverty line, of individuals considered poor (with a lower *per capita* family income or equal to half a minimum wage), illiterate people in charge, illiterate females in charge, households without a restroom and male individuals I charge of the household (Table 3).

The application of the MRLS showed statistical and inverse significance between the transformed rate of AIDS and the FHS coverage (T-Statistic = -14.85 and p = 0.000). However, significant and direct relation to the average of household members, the proportion of households with three or more restrooms, the proportion of illiterate female people in charge of the household, and the average *per capita* household income (Table 4) were verified. The rates of AIDS were higher when the values of these variables had larger proportions.

The spatial autocorrelation of the adjusted values of the AIDS rate was significant (Moran index = 0.61 and p <0.001). The mean income indicator, however, showed a weak influence in the model, with a lower coefficient verified in the regression (T-Statistic = 0.6461). The FHS coverage, however, was shown as an indicator of greater influence (T-Statistic = -14.8527) (Figure 1).

The multivariate analysis showed an adjusted coefficient of determination that explained 28.23% of the variability of the AIDS rate. One can observe the random spatial distribution of the residues (Figure 1), which, by the Moran index, was not significant (p = 0.155). A normality test was carried out to verify whether there were residues with normal distribution. The distribution of the residues was approximated to the normal curve. In this way, the Jarque-Bera index = 4.8 was obtained, with p = 0.09.

DISCUSSION

This study carried out the analysis of multiple socioeconomic determinants in the occurrence of AIDS. Social inequalities in the State of Ceará define inequalities in the pattern of

distribution of AIDS. Differentiated socioeconomic indicators among municipalities are reflected in localities with no or few reported cases, in detriment of other sites with high disease rates.

The present investigation evidenced high rates of AIDS in places with better living conditions, corroborating an earlier study, which also identified higher disease rates among the residents of wealthier households[13]. Previous research, however, has suggested the influence of national *per capita* gross domestic product (GDP) and the Gini index on reducing the incidence rate of HIV / AIDS[14]. Another Brazilian study observed the current challenge of spreading the epidemic among poorer people living in certain regions of the country[15].

Table 2. Spatial autocorrelation of socioeconomic indicators. Ceará, Brazil, 2001–2011*.

Socioeconomic indicators	Moran I	p-value
Population covered by FHS	0.15	0.005
Population covered by PACS	0.21	0.003
Unemployment rate	0.13	0.006
Gini Index	0.23	0.001
Average *per capita* income	0.36	0.001
Proportion of poor people	0.52	0.001
Proportion of owned households	0.35	0.001
Proportion of rented households	0.11	0.013
Proportion of households with water connected to the general network	0.18	0.001
Proportion of households without water not connected to the general network	0.19	0.002
Proportion of households with sanitary sewage	0.18	0.001
Proportion of households without sanitary sewage	0.24	0.001
Proportion of households with open sewage	0.16	0.003
Proportion of households without a restroom	0.28	0.001
Proportion of households with more than three restrooms	0.31	0.001
Proportion of illiterate people in charge	0.50	0.001
Proportion of females in charge of the household	0.17	0.001
Proportion of males in charge of the household	0.16	0.004
Proportion of adequate households	0.18	0.002
Proportion of semi-adequate households	0.15	0.002
Proportion of inadequate households	0.19	0.001

* Data referring to the survey carried out in 2014.
Moran I: Moran Index; FHS: Family Health Strategy; PACS: Community Health Agents Program.

This fact points to the influence of the heterogeneity of Brazilian regions and states on the epidemiological behavior of certain diseases that suffer from their SDH. A mapping study of the circulating volume of HIV/AIDS in the country also revealed the heterogeneity of the infection among Brazilians, with areas of concentration of the community

Table 3. Bivariate spatial autocorrelation of the transformed rate of acquired immunodeficiency syndrome (AIDS) and socioeconomic indicators. Ceará, Brazil, 2001–2011*.

Socioeconomic indicators	Freeman-Tukey AIDS rate		
	Moran I	Statistic-T	p-value
Population covered by FHS	-0.13	-3.10	0.0023
Population covered by PACS	0.06	1.42	0.1580
Unemployment rate	-0.04	-0.89	0.3760
Gini Index	-0.12	-2.46	0.0149
Average *per capita* income	-0.15	-3.59	0.0004
Proportion of poor people	0.24	6.32	0.0001
Proportion of households in the poverty range	0.27	7.31	0.0001
Proportion of owned households	-0.07	-1.72	0.0867
Proportion of rented households	-0.03	-0.69	0.4900
Proportion of households with water connected to the general network	-0.04	-0.92	0.3580
Proportion of households without water not connected to the general network	0.00	0.96	0.3400
Proportion of households with sanitary sewage	-0.04	-0.88	0.3820
Proportion of households without sanitary sewage	-0.07	-1.69	0.0930
Proportion of households with open sewage	0.03	0.59	0.5540
Proportion of households without a restroom	0.15	3.63	0.0003
Proportion of households with more than three restrooms	0.07	1.54	0.0260
Proportion of illiterate people in charge	0.24	6.05	0.0001
Proportion of females in charge of the household	-0.09	-2.20	0.0289
Proportion of males in charge of the household	0.09	2.18	0.0307
Proportion of adequate households	-0.03	-0.76	0.4510
Proportion of semi-adequate households	-0.03	-0.75	0.4540
Proportion of inadequate households	0.00	-0.15	0.8810

* Data referring to the survey carried out in 2014.
Moran I: Moran Index; FHS: Family Health Strategy; PACS: Community Health Agents Program.

viral load between the untreated individuals in the Northeast Region compared to the Center-South Region[16].

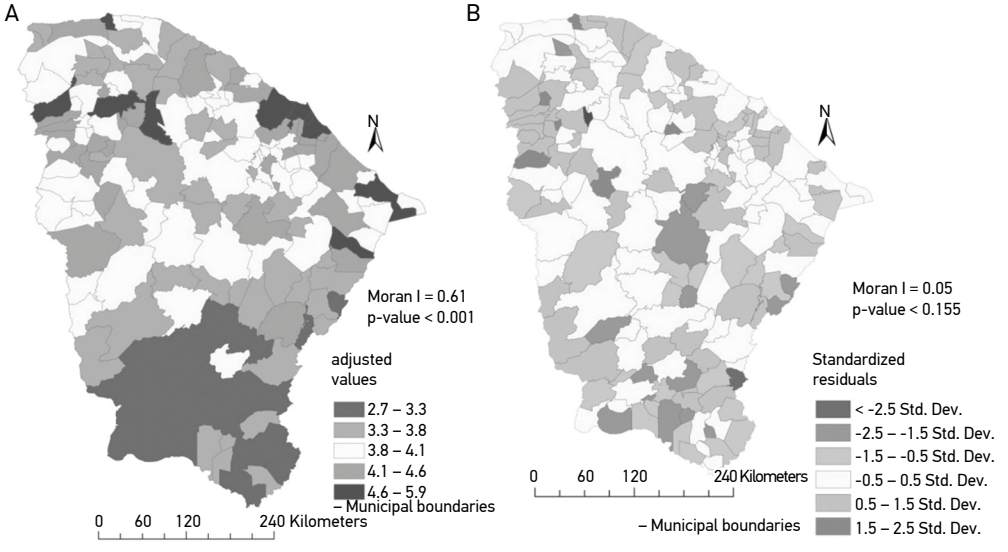
It is considered, therefore, that the area of the studied municipality is heterogeneous and may present greater variability in the distribution of indicators and, consequently, in AIDS rates.

In addition, it is important to consider that the disease is prevalent in large cities of the state, where the family income is highest. Thus, AIDS may be predominantly more associated with the pace and risk behaviors of modern and urban life than with poverty-related factors.

Table 4. Simple linear regression between the transformed rate of acquired immunodeficiency syndrome (AIDS) and socioeconomic indicators. Ceará, Brazil, 2001–2011*.

Variable	Coefficient	Standard deviation	Statistic-T	p-value
Constant	-0.3884	0.1931	-2.0112	0.0458
FHS Coverage	-0.1527	0.0103	-14.8527	0.0000
Average number of residents per household	0.1017	0.0493	2.0638	0.0405
Proportion of poor people	0.0069	0.0027	2.5296	0.0123
Households with more than three restrooms	0.0478	0.0171	2.7885	0.0059
Female illiterate in charge of the household	-0.0179	0.0048	-3.7361	0.0003
Average *per capita* income	0.0570	0.0882	0.6461	0.5191

* Data referring to the survey carried out in 2014.
FHS: Family Health Strategy.



* Data referring to the survey carried out in 2014.
Moran I: Moran index; Std. Dev.: standard deviation.

Figure 1. Adjusted values of the global simple linear regression model (A) and model residuals (B). Ceará, Brazil, 2001–2011*.

The 2010 Census found an improvement in the country's social indices compared to previous years. This result, however, diverges among Brazilian regions. The Northeast, which contains Ceará, has the highest illiteracy rate in the country, with 17.6%, as opposed to the South Region, with only 4.7%[17].

Ceará itself does not have equitable socio-economic indexes in its geographic space, since more than 75% of the literate individuals live in the urban area[11]. With regard to AIDS, however, previous studies have not identified a higher level of schooling with knowledge about the disease, let alone with behaviors for the prevention and control of illness[18].

The increase in disease rates, verified not only in large urban centers, but also in small municipalities, is a factor that assists managers and health professionals in the planning of strategies for the control of the syndrome[19].

A direct association between AIDS and rented property was observed. One study also found a relationship between stable homelessness and difficulties in accessing medical care and adherence to antiretroviral treatment for people with HIV/AIDS[20]. In addition, it can be said that the constant change of residential address can increase the network of sexual partners, increasing the probability of contact with infected partners.

The positive association between *per capita* income and AIDS rates, evidenced between the two variables in this study, was explained in a previous study, which identified ease and greater access to diagnostic tests and serological testing in territories with better economic conditions[18]. Still on regional disparities, the important elements in HIV/AIDS care should be socioeconomic and health deficiencies among low-income countries, while in rich countries aspects to be considered are clinical, psychosocial and sexual identity issues[21].

There was a significant relationship between primary health care coverage (FHS and PACS) and low rates of AIDS in Ceará. It is possible to affirm that the internalization process of AIDS was accompanied by the expansion of primary health care in different municipalities of the state. This fact, associated to public policies to combat AIDS, which defines strategies for health promotion, prevention and early diagnosis, may have contributed to the low rates of disease in regions with greater coverage of FHS and PACS teams. FHS reduces geographic barriers by acting near the household of the people under its responsibility. Spatial disparities define geographical access and the effectiveness of interventions in health institutions[22].

The use of spatial correlation and SLRM allowed the identification of socioeconomic characteristics related to the difference in AIDS rates found in the state of Ceará. The contemporary use of spatial modeling tools has allowed the formulation of intervention strategies, integrating public health with other sectors[23].

Despite the important results found, it is important to mention the limitations of the present study, which are related to the low quality verified in the registry of some data obtained and the underreporting of the cases in the state. Potential damage caused by poor record quality and underreporting of cases would conceal the actual disease situation in Ceará. However, SINAN, used in the present study, was considered the most adequate source of data to reach the defined objectives, due to the large amount of information contained in the system. On the other hand, the integration of data provided by other systems that also manipulate information related to HIV/AIDS, such as the Laboratory Examination Control

System (*Sistema de Controle de Exames Laboratoriais* – SISCEL) and the Logistic Control System of Medicines (*Sistema de Controle Logístico de Medicamentos* – SICLOM), could have collaborated to decrease under-reporting of disease cases.

Also, because it is an ecological study, it is not possible to make individual inferences regarding the results. Such restrictions, however, did not compromise the main findings and the relevance of the research, since the objective was to identify the socioeconomic indicators that interfere in the detection rates of AIDS in the population of Ceará.

CONCLUSION

AIDS rates were higher where there were better living conditions. It was observed that sites with greater coverage of FHS and PACS have lower rates of AIDS detection. It can be concluded that social disparities can lead to different vulnerabilities of the disease in the same geographic territory.

This research may contribute to the understanding of the relationship between SDH and AIDS. This way, the political and assistance actions to control the epidemic can be directed to the most relevant SDH. Identifying social elements that affect the health/disease process of AIDS allows directing the planning of actions, both at the macro level, in the establishment of public health policies and programs of care, and at the level of less complexity, in the care context of individuals affected by the infection.

The techniques of autocorrelation and spatial analysis adopted, using GIS resources, were very useful to verify the epidemiological patterns of the distribution of a certain disease and its relation with other factors characteristic of the geographic space. This technology can be replicated in AIDS studies in other locations, as well as being useful for revealing epidemiological patterns of other diseases.

Due to the social inequalities between municipalities, it is recommended to carry out researches considering smaller units of analysis and comparative investigations between different territories, in order to better understand the dynamics of SDH in different locations. It is also recommended to apply this study design to AIDS rates transformed by gender and age group to evaluate if the impact of SDH in different subgroups occurs unequally.

REFERENCES

1. Greco DB. Trinta anos de enfrentamento à epidemia da aids no Brasil, 1985-2015. Ciênc Saúde Coletiva 2016; 21(5): 1553-64. http://dx.doi.org/10.1590/1413-81232015215.04402016
2. Joint United Nations Programme on HIV/AIDS. UNAIDS data 2017 [Internet]. Joint United Nations Programme on HIV/AIDS; 2017 [acessado em 20 dez. 2017]. Disponível em: http://www.unaids.org/sites/default/files/media_asset/20170720_Data_book_2017_en.pdf
3. Brasil. Ministério da Saúde. Secretaria de Vigilância em Saúde. Departamento de Aids, DST e Hepatites Virais. Boletim epidemiológico aids e DST. Brasília: Ministério da Saúde; 2017.
4. Gueler A, Schoeni-Affolter F, Moser A, Bertisch B, Bucher HC, Calmy A, et al. Neighbourhood socio-economic position, late presentation and outcomes in people living with HIV in Switzerland. J Int Aids Soc 2015; 29(2): 231-8. https://doi.org/10.1097/QAD.0000000000000524

5. Andrade LOM, Pellegrini Filho A, Solar O, Rígoli F, Salazar LM, Serrate C, et al. Social determinants of health, universal health coverage, and sustainable development: case studies from Latin American countries. The Lancet 2015; 385(9975): 1343-51. https://doi.org/10.1016/S0140-6736(14)61494-X
6. Herbst JH, Painter TM, Tomlinson HL, Alvarez ME; Centers for Disease Control and Prevention (CDC). Evidence-based HIV/STD prevention intervention for black men who have sex with men. MMWR 2014; 63(Supl. 1): 21-7.
7. Smith JA. Reflections on the framing of 'health equity' in the National Primary Health Care Strategic Framework: a cause for celebration or concern? Health Promot J Austr 2014; 25(1): 42-5. https://doi.org/10.1071/HE13106
8. Williams SD, Hansen K, Smithey M, Burnley J, Koplitz M, Koyama K, et al. Using social determinants of health to link health work force diversity, care quality and access, and health disparities to achieve health equity in nursing. Public Health Rep 2014; 129(Supl. 2): 32-6. https://dx.doi.org/10.1177%2F00333549141291S207
9. Haleya D, Matthews SA, Cooper HLF, Haardörfer R, Adimora AA, Wingood GM, et al. Confidentiality considerations for use of social-spatial data on the social determinants of health: Sexual and reproductive health case study. Soc Sci Med 2016; 166: 49-56. https://doi.org/10.1016/j.socscimed.2016.08.009
10. Brasil. Ministério da Saúde. Secretaria de Vigilância em Saúde. Departamento de Aids, DST e Hepatites Virais. Boletim Epidemiológico Aids e DST. Brasília: Ministério da Saúde; 2016.
11. Ceará. Governo do Estado do Ceará. Instituto de Pesquisa e Estratégia Econômica do Ceará. Ceará em números [Internet]. Fortaleza: Instituto de Pesquisa e Estratégia Econômica do Ceará; 2015 [acessado em 18 dez. 2017]. Disponível em: http://www2.ipece.ce.gov.br/publicacoes/ceara_em_numeros/2015/completa/Ceara_em_Numeros_2015.pdf
12. Gonçalves AC, Costa MCN, Braga JU. Análise da distribuição espacial da mortalidade neonatal e de fatores associados, em Salvador, Bahia, Brasil, no período 2000-2006. Cad Saúde Pública 2011; 27(8): 1581-92. http://dx.doi.org/10.1590/S0102-311X2011000800013
13. Bingenheimer JB. Men's multiple sexual partnerships in 15 Sub-Saharan African countries: sociodemographic patterns and implications. Stud Fam Plann 2010; 41(1): 1-17. https://doi.org/10.1111/j.1728-4465.2010.00220.x
14. Escobar-Leguízamo DN, Suárez EP, Montoya JHE. Determinantes estructurales de países con decrecimiento en la prevalencia por la infección VIH/SIDA en el periodo 2001-2011. Rev Salud Pública 2014; 16(6): 924-36. https://doi.org/10.15446/rsap.v16n6.49250
15. Vieira ACS, Rocha MSG, Head JF, Casimiro IMAPC. A epidemia de HIV/Aids e a ação do Estado. Diferenças entre Brasil, África do Sul e Moçambique. Rev Katálysis 2014; 17(2): 196-206. http://dx.doi.org/10.1590/S1414-49802014000200005
16. Sousa AIA, Pinto Junior VL. Carga viral comunitária do HIV no Brasil, 2007 - 2011: potencial impacto da terapia antirretroviral (HAART) na redução de novas infecções. Rev Bras Epidemiol 2016; 19(3): 582-93. http://dx.doi.org/10.1590/1980-5497201600030009
17. Brasil. Instituto Brasileiro de Geografia e Estatística. Base de dados de informações do Censo Demográfico 2010: resultado do universo por setor censitário. Rio de Janeiro: Ministério de Planejamento, Orçamento e Gestão; 2011.
18. Godoy MR, Sousa TRV, Silva EN. O impacto do status socioeconômico na incidência de casos de aids nos municípios brasileiros: estudos por dados em painel. Econ Região 2013; 1(1): 4-25. http://dx.doi.org/10.5433/2317-627X.2013v1n1p4
19. Nogueira JA, Silva AO, Sá LR, Almeida SA, Monroe AA, Villa TCS. AIDS in adults 50 years of age and over: characteristics, trends and spatial distribution of the risk. Rev Latino-Am Enfermagem 2014; 22(3): 355-63. http://dx.doi.org/10.1590/0104-1169.3327.2424
20. Aidala AA, Wilson MG, Shubert V, Gogolishvili D, Globerman J, Rueda S, et al. Housing status, medical care, and health outcomes among people living with HIV/AIDS: a systematic review. Am J Public Health 2016; 106(1): e1-23. https://doi.org/10.2105/AJPH.2015.302905
21. Gari S, Doig-Acuña C, Smail T, Malungo JR, Martin-Hilber A, Merten S. Access to HIV/aids care: a systematic review of socio-cultural determinants in low and high income countries. BMC Health Serv Res 2013; 13: 198. https://doi.org/10.1186/1472-6963-13-198
22. Yao J, Murray AT, Agadjanian V. A geographical perspective on access to sexual and reproductive health care for women in rural Africa. Soc Sci Med 2013; 96(11): 60-8. https://doi.org/10.1016/j.socscimed.2013.07.025
23. Lal A. Spatial modelling tools to integrate public health and environmental science, illustrated with infectious cryptosporidiosis. Int J Environ Res Public Health 2016; 13(2): 186. https://doi.org/10.3390/ijerph13020186

Received on: 08/09/2017
Reviewed on: 04/25/2018
Accepted on: 05/15/2018

Authors' contribution: Simone de Sousa Paiva and Nathália Lima Pedrosa contributed significantly in the elaboration of the article; Marli Teresinha Gimeniz Galvão participated substantially in the design, planning, analysis and interpretation of the data.