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Original Article

Distribution and spatial autocorrelation of HIV self-tests

Distribuição e autocorrelação espacial dos autotestes de HIV

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ABSTRACT

Objective: to analyze the distribution and spatial autocorrelation of HIV self-testing rates. **Methods:** this is an ecological study of distributed HIV self-tests. The records were obtained from secondary data from the Medicines Logistics Control System. Moran's autocorrelation coefficient was used for statistical analysis of spatial dependence. **Results**: 622,822 HIV self-test records made available in Brazil were analyzed, showing positive spatial autocorrelation with a Global Moran's Index of 0.199 (p=0.046) over the period. There has been an increase in HIV self-testing rates over the years, with the highest rates concentrated in the South and North of Brazil, with a higher concentration of distribution in the 25-29 age group. **Conclusion**: despite the increase in HIV self-testing rates, there are still significant disparities between states, indicating that strategies for HIV self-test distribution and use are needed in the country. **Contributions to practice**: this work contributes to the improvement of strategies and the (re)formulation of new health policies aimed at expanding the diagnosis of individuals who have HIV and don't know it.

Descriptors: HIV; Self-Testing; Early Diagnosis; Therapeutics.

RESUMO

Objetivo: analisar a distribuição e autocorrelação espacial das taxas de autoteste de HIV. **Métodos:** estudo ecológico, referente aos autotestes de HIV distribuídos. Os registros foram obtidos a partir de dados secundários do Sistema de Controle Logístico de Medicamentos. Utilizou-se o coeficiente de autocorrelação de Moran para análise estatística da dependência espacial. **Resultados:** foram analisados 622.822 registros de autoteste de HIV disponibilizados no Brasil, apresentando autocorrelação espacial positiva com o Índice de Moran Global de 0,199 (p=0,046) no período. Ocorreu um aumento das taxas de autoteste de HIV ao longo dos anos, sendo que as maiores taxas estiveram concentradas nas regiões Sul e Norte do Brasil, com maior concentração de distribuição na faixa etária entre 25 e 29 anos. **Conclusão:** mesmo diante do aumento das taxas de autoteste de HIV, ainda há importantes disparidades entre os estados, sinalizando que estratégias para distribuição do autoteste de HIV e utilização são necessárias no país. **Contribuições para prática:** este trabalho contribui para fomentar o aprimoramento de estratégias e a (re)formulação de novas políticas de saúde voltadas à expansão do diagnóstico de indivíduos que têm HIV e não sabem.

Descritores: HIV; Autoteste; Diagnóstico Precoce; Terapêutica.

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Introduction

Infection with the Human Immunodeficiency Virus (HIV), which causes acquired immunodeficiency syndrome (AIDS), is a global public health problem. In 2023, 39.9 million people were living with HIV in the world. Of these, 1.3 million were infected in the same year, and around 630,000 died from AIDS. In Brazil, there were approximately 42,700 new cases of HIV in 2022[1]. The challenge of reducing the number of infections is immense, but it is believed that we have never been so close to eliminating the transmission of disease as we are today[1-2].

With this in mind, the Joint United Nations Program on HIV/AIDS (UNAIDS) has set the ambitious "95-95-95" target, aiming for a global commitment to eliminate the AIDS epidemic by 2030. To achieve this goal, 95% of people need to be aware of their diagnosis, 95% of people living with the disease need to start treatment, and 95% of those infected and on treatment need to have viral suppression[2].

Brazil, a signatory to the UNAIDS targets, has improved its HIV prevention and detection strategies. In addition, as a new strategy for achieving the goals, one of the actions provided for in the "Combined Prevention" model includes self-testing, as a strategy that will help diagnose the disease, especially for those without access to tests, thus living up to the principles of the Unified Health System (UHS)[3].

HIV self-testing (HIVST) has been a tool that enables greater autonomy and access to testing for key populations, technically considered more vulnerable to contact with the virus. These populations include sex workers, men who have sex with men, people who inject drugs, the trans population, and people deprived of their liberty[4]. HIVST is a strategy for decentralizing actions within the scope of primary health care, with numerous advantages in terms of acceptability, convenience, and patient privacy[3-4].

In addition, other benefits that have been highlighted include the practicality of doing it at home, the autonomy of doing it whenever and wherever you want, as well as the reduction of stigma, the preservation of privacy, and ease of use, which favors a greater frequency of testing. However, there are still few studies looking at preferences and considerations for its use as a tool for HIV prevention[5].

It should be noted that Brazil's regional dimensions and the existence of inequalities in the country imply the possibility of disparities in the levels of distribution of HIVST, pointing to the importance and need for studies with different territorial cutouts, capable of signaling areas that require greater encouragement and attention.

In addition, it should be noted that no studies on the spatial autocorrelation of HIVST distribution in Brazil have been identified in the scientific literature, which suggests the need to explore this issue, not least as a way of strengthening actions to monitor the results of public policy on test distribution. Therefore, this study aimed to analyze the distribution and spatial autocorrelation of HIV self-testing rates.

Methods

This is an ecological study of HIV self-tests distributed in Brazil between December 2018 and March 2023. Considered one of the most populous countries in the world and the largest country in South America, Brazil has an estimated population of 212 million people in 2024, with an area of more than 8.5 million km^2, made up of 26 states and the federal district[6].

The records were obtained from secondary data from the Self-Test Strategy Monitoring Panel[7], a platform used to record the delivery of the self-test. The data was collected between May and July 2023.

The variables analyzed were: self-test distribution status, year, age, and people living with HIV and already diagnosed who acquired HIVST. Considering the possibility of random fluctuations in HIVST dis-

tribution numbers, the rates were obtained by taking the ratio of HIV self-test records offered, added to the respective population in the same period, and multiplied by 100,000. The results obtained were organized in Microsoft Office Excel® spreadsheets, separated according to the year of the report analyzed.

The states were the units considered for the analysis of distribution and spatial autocorrelation. A cartographic base with the boundaries of the states is available online in Shapefile (SHP) on the website of the Brazilian Institute of Geography and Statistics[8].

The rates were represented on choropleth maps by color scales, with the darker ones representing locations with higher rates and the lighter ones those with lower rates. Moran's autocorrelation coefficient was used for the statistical analysis of spatial dependence, subdivided into the Global and Local Moran's Indices. The Global Moran's Index allowed analysis of the variable's spatial distribution pattern according to state. This index varies between -1 and 1, with values close to zero indicating the absence of spatial autocorrelation, positive values indicating positive spatial autocorrelation, and negative values indicating negative autocorrelation[9].

The Local Indicator of Spatial Association (LISA) provides information on the different types of association: high-high, when the ratio of the HIV self-test distribution rate between a state and its neighbor is high, and low-low when it is low in both states. It is also possible to find outliers, when one state's ratio is high and its neighbor's is low, or the opposite. In these cases, we present high-low and low-high associations, respectively. For states that do not show a statistically significant spatial trend, since they have high rates around them along with low rates, they are classified as non-significant. A 5% significance level was used[9]. The statistical analyses were carried out using GeoDa software version 1.18, and the maps were drawn up using QGIS software version 3.10.

As this was a study using secondary data, in the public domain, aggregated, with no risk to the population or nominal identification of the subjects, this study was exempt from consideration by the Research Ethics Committee.

Results

We analyzed 622,822 records of HIV self-tests available in Brazil for both sexes, from December 2018 to March 2023. The states with the highest rates throughout the study period were Rio Grande do Sul, Santa Catarina, São Paulo, Acre, Amazonas, and Roraima, with rates ranging from 448.46 to 1829.40 per 100,000 inhabitants (Figure 1).

The Global Moran's Index showed positive spatial autocorrelation for the distribution of HIV self-tests, with a value of 0.199 (p=0.046). Clusters were established based on the states that showed a significant relationship between HIVST rates and place of residence. The results indicated similar patterns of states with low rates: Tocantins, Bahia, Piauí, Pernambuco, and Paraíba (low-low). High-high autocorrelation occurred only in the state of Santa Catarina, with no statistical significance in the other neighboring states, such as Paraná (Figure 1).

The spatial distribution revealed that there was an increase in HIVST rates over the period analyzed, except for Minas Gerais when considering the years 2019 to 2022. The highest rates were concentrated in the southern and northern regions of Brazil, with the distribution rates in 2022 in the states of Santa Catarina, Paraná, Rio Grande do Sul, Rio de Janeiro, Espírito Santo, Amazonas, Acre, Rondônia, and Amapá standing out, with rates varying between 77.47 and 1040.63 per 100,000 inhabitants. Similarly, the lowest rates were found in Mato Grosso, but in this cluster, the Global Moran Index identified a negative spatial autocorrelation of -0.003 (p=0.296) (Figure 2).

In 2023, there was a positive spatial autocorrelation of 0.224 (p=0.039), with high-high clusters in the states of Paraná and Mato Grosso do Sul; low-high clusters in Rio Grande do Sul and Minas Gerais; and low-low clusters in the states of Maranhão, Piauí, Ceará, Paraíba, and Pernambuco (Figure 2).

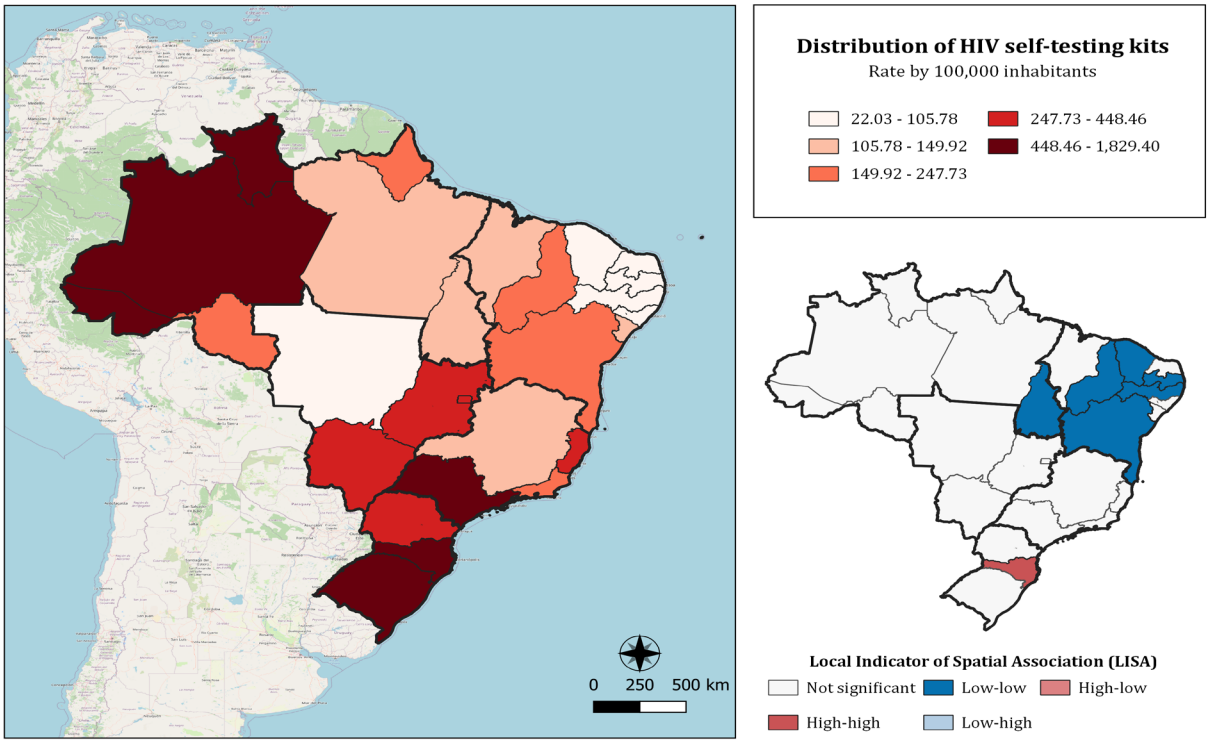


Figure 1 – Distribution and spatial autocorrelation of HIV self-testing rates among people living with HIV according to the Local Moran Index. Maringá, PR, Brazil, 2018-2023

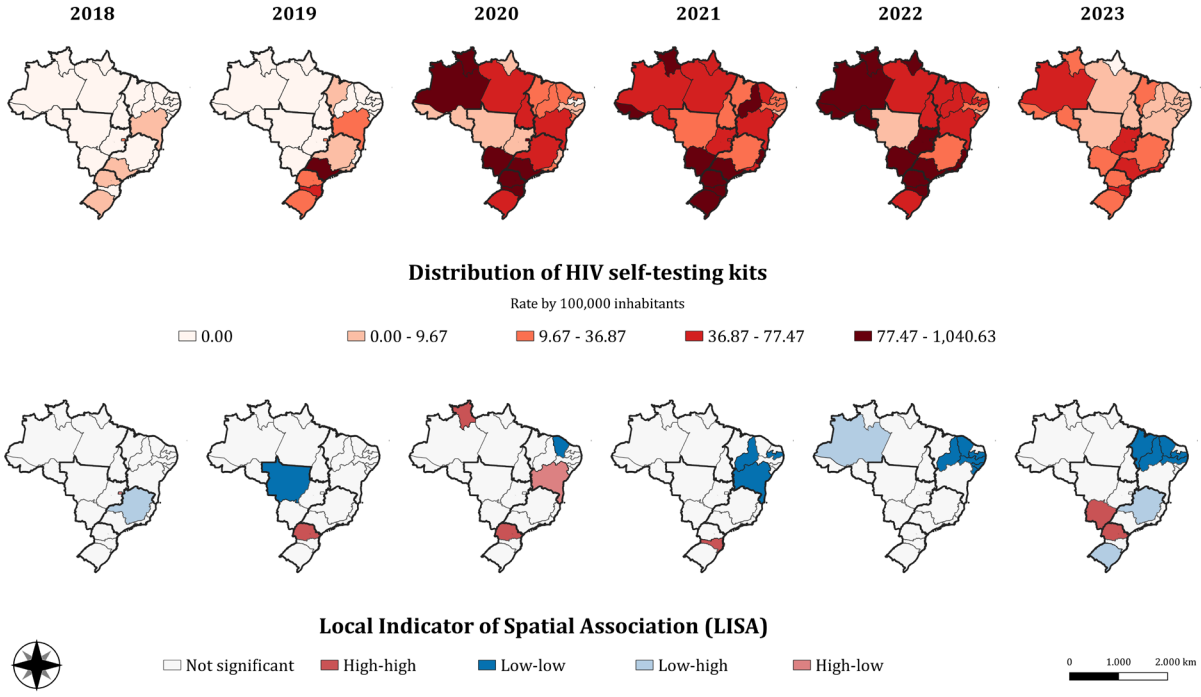


Figure 2 – Distribution and spatial autocorrelation of HIV self-testing rates according to the Local Moran Index, by year. Maringá, PR, Brazil, 2018-2023

There was a higher concentration of self--test distribution in the 25-29 age group, with rates of 126.70 to 1296.22 per 100,000 inhabitants in the states of Rio Grande do Sul, Paraná, Santa Catarina, Mato Grosso do Sul, Amazonas, Acre, Roraima, Bahia, Espírito Santo and Rio de Janeiro. The lowest concentration of self-test distribution was in the under-18 age group in all regions of Brazil, with a negative autocorrelation cluster showing a Global Moran's Index of -0.059 (p=0.488) (Figure 3).

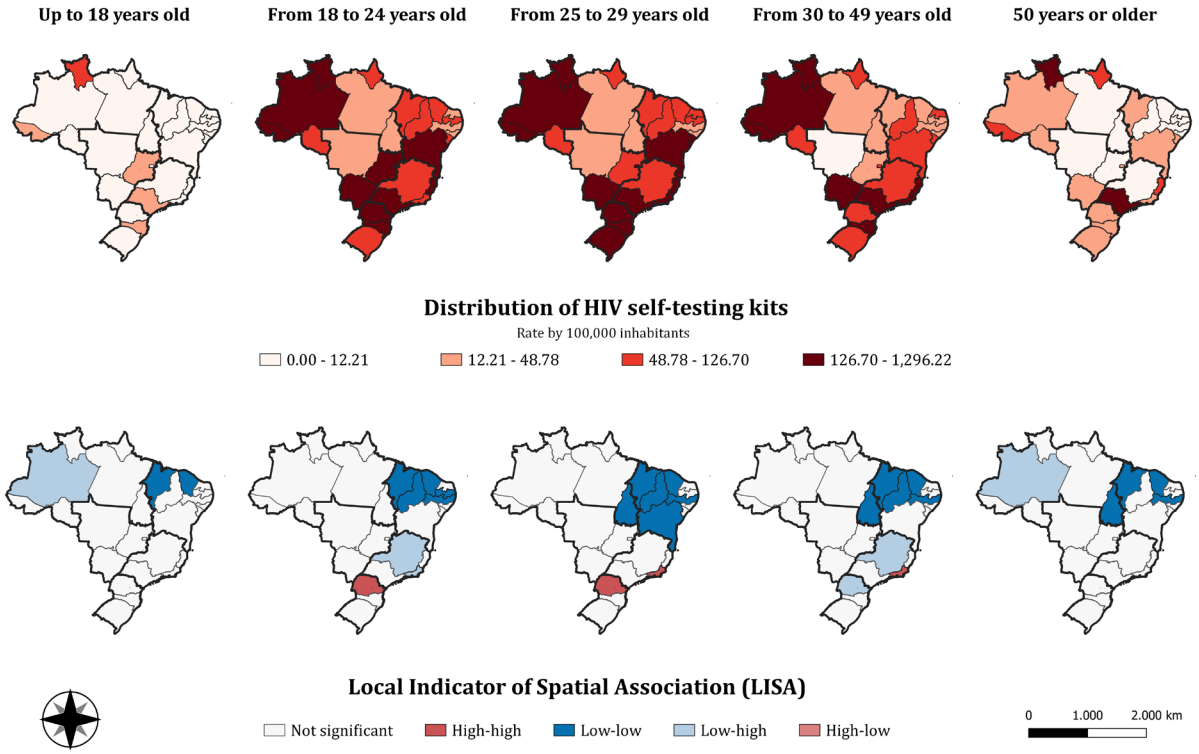
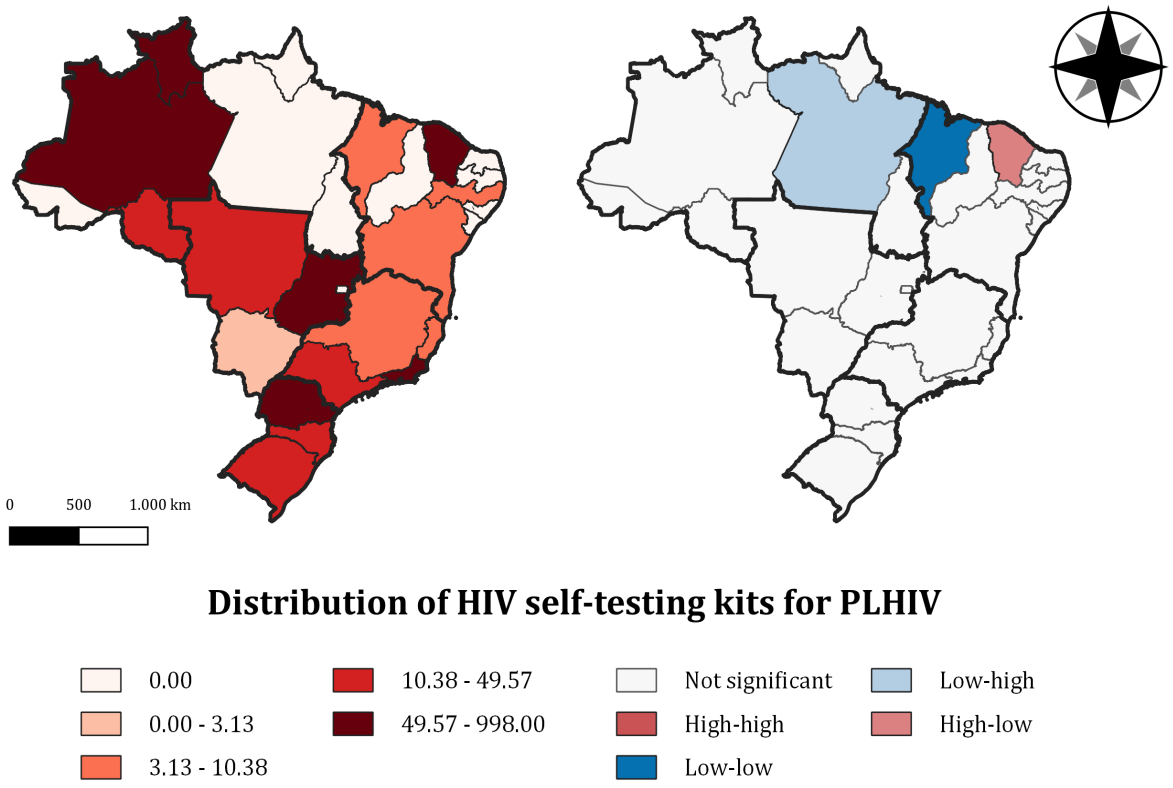


Figure 3 – Distribution and spatial autocorrelation of HIV self-testing rates according to the Local Moran Index, by age group. Maringá, PR, Brazil, 2018-2023

Concerning the distribution of self-tests to people living with HIV, who generally end up withdrawing tests for their non-reactive partners, the highest rates were found in the states of Paraná, Amazonas, Goiás, Rio de Janeiro, and Ceará. Lower rates were also found in the states of Acre, Amapá, Tocantins, Piauí, Rio Grande do Norte, Paraíba, Sergipe, and Alagoas, with rates ranging from 49.57 to 998.00 per 100,000 inhabitants. Low-low spatial autocorrelation was observed in the state of Maranhão; low-high in Pará; and high-low in Ceará (p=0.062) (Figure 4).



PLHIV: People living with HIV

Figure 4 – Distribution and spatial autocorrelation of HIV self-testing rates according to the Local Moran Index, according to people living with HIV during the period. Maringá, PR, Brazil, 2018-2023

Discussion

Identifying the correlation using spatial analysis tools made it possible to analyze the most vulnerable states with the event and the states that are close to each other, as well as to learn about the distribution of HIV self-tests.

The data showed that dispensing in Brazil was concentrated in the North, South, and Southeast regions, with a low concentration in the Northeast. However, it was possible to identify a significant increase in distribution in practically all regions of Brazil. It is noteworthy that even though health professionals in Brazil are aware of the need to make HIVST available, acceptability and willingness to provide it are still moderate. As such, scale-up is a policy strategy for HIV prevention and control, requiring training for professionals and incentives to implement this program[10].

It is clear that the number of individuals undergoing treatment for the disease is growing, and it is possible to observe the importance of using HIVST to contribute to early detection, with a view not only to reducing the morbidity and mortality of people living with the disease but also to preventing transmission of the virus to other people and not developing AIDS[11].

The low concentration of HIVST distribution, especially in the northeast of Brazil, may be related to the limited supply of actions and services related to Sexually Transmitted Infections (STIs), as well as the difficulty in acquiring these new strategies. It is, therefore, possible to say that cultural factors and socio-economic resources influence tackling this public

health problem, whether due to the lack of supply of condoms, rapid tests, and HIVST, or the lack of training for health professionals, with the consequent compromise of activities to guide the population. In addition, there are low HIV detection rates in the northeast of Brazil, although the coasts of Paraíba and Pernambuco have higher rates, which is understood to be a reflection of sex tourism[12].

It was possible to correlate the higher HIVST distribution rate with the Southeast, the region with the highest HIV infection rate and considered one of the most developed in Brazil. The high rate of infection in this region may be related to greater access to diagnosis and the high rate of tourism in the region, increasing the likelihood of contracting the infection from outside. The area also has a higher concentration of young working-age residents, who are in constant contact with the outside world. The privacy benefits of HIV self-testing minimize the breach of confidentiality by health professionals, which is reported during the usual testing in health units [13-14].

Concerning HIVST dispensation by age group, the findings of this study showed that the most prevalent age group was between 18 and 29 years old. It is noteworthy that in the 15-29 age group there was a 29.0% increase in HIV cases, which reinforces the importance of this new strategy to contribute to early diagnosis[1]. However, this age group is considered to be more educated, and they are often university graduates, so they realize the importance of this strategy. A study carried out in Nigeria shows that time at university, age, ethnicity, and study program are associated with willingness to take the self-test[15].

In addition, there is also a low concentration of adolescents throughout Brazil. There is a concern about testing this age group, as it is related to the increase in HIV cases among men who have sex with men, since a prevalence of 5.9% of HIV was identified among men aged 15 to 19, showing a significant association with the use of apps to look for sexual partners, sex work, lower schooling, a history of not being hired or dismissed due to sexual orientation and lack of use of the health service[16]. That said, it is important to raise awareness and implement HIVST in partnership with the disease prevention and treatment services in the places where this public is found[17].

In this context, the sexual behavior of this age group can be considered another challenge for public health, as multiple related factors point to young people as a risk group for sexually transmitted infections, such as the vulnerability of this population, given that it is a phase of age, cognitive and emotional immaturity, and of great influence from social groups[18].

It is important to note that HIVST contributes to expanding the possibilities of access to testing for these vulnerable groups, known as key populations, helping to reduce the number of deaths, that are prevalent in this population due to the vulnerabilities of diagnosing and treating these individuals[19].

The distribution rate for people living with HIV may be correlated with serodiscordant couples, where the partner often doesn't seek care due to stigma. In addition, the longer the couple has been in a relationship, the less they demand condom use because condom use is mostly viewed with suspicion in the relationship. Concerning serodiscordant couples, it is worth highlighting the fact that, not infrequently, the partner may be seropositive and unaware of their serology, which shows the importance of having several possibilities for testing for the disease [20-21].

In addition, women who have not acquired the disease are more likely to give HIVST to their partners when compared to HIV-positive women, because they feel more hesitant due to concerns about discovering their HIV status and dissolving the relationship. However, pregnancy was considered a critical motivator for men's adoption of this strategy and health-improving behaviors[22].

That said, expanding the distribution of this strategy could mitigate disparities in access to HIV diagnosis, reducing morbidity and mortality among key populations and their partners[23]. Even so, it is

important to integrate peer services in the differentiated delivery of the self-test to increase testing coverage among the public, which is considered vulnerable[24]. Therefore, HIV self-testing makes it possible to fill the gap in HIV diagnosis. Future HIV testing programs need to prioritize education on the subject with accurate information and timely services[25].

Study limitations

The study's limitations include the fact that data was collected on an online platform, where the number of self-tests distributed is constantly updated. Furthermore, these sources may be subject to failures in filling out the HIVST form completely. However, this study had the additional motto of serving as a stimulus and subsidy for future epidemiological research on the spatial analysis of self-tests, in order to help health managers at the state and municipal level to develop strategies to optimize the early diagnosis of HIV/AIDS in our country.

Contributions to practice

This type of study can encourage the improvement of strategies and the (re)formulation of new health policies aimed at expanding the diagnosis of individuals who have HIV and don't know it, contributing to early diagnosis and a better quality of life for this clientele.

Conclusion

A direct spatial autocorrelation was observed between the HIV self-tests distributed across the Brazilian states. Disparities were identified between the states in terms of the distribution of self-tests, indicating that some had more self-tests distributed (Rio Grande do Sul, Santa Catarina, São Paulo, Acre, Amazonas, and Roraima) than others (Mato Grosso).

The clusters with a low distribution of HIV self--tests, with negative autocorrelation (Tocantins, Bahia, Pernambuco, and Paraíba, as well as among children under 18 throughout Brazil), make it possible to identify priority regions. Thus, the results on the distribution of HIV self-testing reinforce the importance of its dispensation in the Unified Health System.

Authors' contribution

Conception and design or analysis and interpretation of data; Writing of the manuscript or relevant critical review of the intellectual content; Final approval of the version to be published; Responsibility for all aspects of the text and for ensuring the accuracy and integrity of any part of the manuscript: Vieira JP, Piran CMG, Oliveira NN, Furtado MD, Oliveira RR, Higarashi IH.

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