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REVIEW

The evolution of HIV in Southern Brazil: demographic trends from 2011 to 2021

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ABSTRACT. This study analyzes the demographic profiles of HIV patients in Southern Brazil from 2011 to 2021, with a focus on the states of Rio Grande do Sul, Santa Catarina, and Paraná, using data from the DATASUS system. A total of 87,025 diagnosed cases were reported, with Rio Grande do Sul accounting for the highest proportion (48%), followed by Santa Catarina (27%) and Paraná (25%). Linear regression analysis revealed a general decline in HIV notifications across all three states, suggesting improvements in public health measures. Gender analysis indicated a higher prevalence among men (62%), and a greater reduction in cases among women over the decade. The data also highlighted disparities in HIV incidence related to race/ethnicity and age, with the white population showing the highest number of notifications and the 20-49 age group being the most affected. Educational level analysis pointed to a significant number of cases among individuals with elementary education. Our findings emphasize the importance of tailored public health strategies to address the diverse factors influencing HIV transmission. Continued efforts in prevention, accurate data reporting, and targeted interventions are crucial to sustaining the downward trend and addressing the specific needs of vulnerable populations.

Keywords: Human Immunodeficiency Virus; Paraná; Rio Grande do Sul; Santa Catarina.

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Introduction

Since the 1980s, healthcare professionals have faced the challenge of a novel disease, officially designated as Acquired Immunodeficiency Syndrome (AIDS) in 1982. This marked a pivotal moment in understanding the disease's origins and its causative agent, the Human Immunodeficiency Virus (HIV). HIV spreads through sexual contact, intravenous drug use, and exposure to contaminated body fluids, highlighting the complexity of its transmission (Nascimento, 2005).

The Human Immunodeficiency Virus belongs to the Retroviridae family, Orthoretrovirinae subfamily, and *Lentivirus* genus, with RNA as its genetic material (Nastri et al., 2023). Two types of HIV have been identified: HIV-1 and HIV-2 (Bbosa et al., 2019). HIV-1, the most prevalent type globally, is categorized into groups M, O, N, and P, with group M being the most widespread and comprising nine subtypes (Hemelaar et al., 2006; Sharp & Hahn, 2011). In Brazil, HIV-1B is the predominant subtype, except in the South, where HIV-1C is more prevalent (Gräf et al., 2021).

Upon entering the human body, HIV primarily targets CD4 cells, which are crucial for immune system function. CD4+ lymphocytes (T-helper cells) and macrophages are the virus's main targets, using the CD4 molecule as a receptor to invade cells (Février et al., 2011). As HIV replicates, it destroys CD4 cells, weakening the immune system and leading to AIDS, which makes the body vulnerable to opportunistic infections (Rachid & Schechter, 2017).

Initial indications of infection are marked by the presence of viral RNA, which is detectable within 12 days post-exposure and peaks around 20-30 days. Capsid protein p24 levels become detectable by the 15th day (Hurt et al., 2017). Early HIV treatments, such as zidovudine (AZT), emerged in the 1980s and 1990s, but were associated with severe side effects and lower efficacy compared to modern treatments (Cihlar & Ray, 2010; Gallant, 2002).

Current therapies, known as highly active antiretroviral therapy (HAART) or combined antiretroviral therapy (cART), effectively control HIV replication, enabling individuals to lead near-normal lives (Weichseldorfer et al., 2021). Prevention methods such as pre-exposure prophylaxis (PrEP) and post-exposure

prophylaxis (PEP) further help reduce transmission (Rowan et al., 2021; Cresswell et al., 2022). Since 1996, Brazil has provided free antiretroviral medications, and since 2013, it has endorsed treatment initiation regardless of symptoms or CD4 count (Cueto & Lopes, 2021; Benzaken et al., 2019). However, despite these efforts, approximately 15,000 Brazilians died from HIV-related causes in 2022 (World Health Organization [WHO], 2024).

Despite significant advancements, HIV continues to persist and spread. This study addresses a critical gap by analyzing the demographic profiles of HIV patients in Southern Brazil from 2011 to 2021, aiming to enhance understanding and inform targeted interventions.

Materials and methods

Data collection

This study is a descriptive, retrospective epidemiological analysis that utilized data retrieved from the Brazilian Notifiable Diseases Information System (SINAN, as per its acronym in Portuguese), provided by the Department of Informatics of the Unified Health System (DATASUS, as per its acronym in Portuguese) (Brazil, 2023). To access the data, the following steps were undertaken: tabnet → epidemiology and mortality → AIDS cases since 1980. The study incorporated cases diagnosed and reported in Brazil from January 1, 2011, to December 31, 2021, specifically focusing on the Southern region of Brazil (the states of Paraná, Santa Catarina, and Rio Grande do Sul), as available on DATASUS. Variables such as gender, age, education level, race/ethnicity, and mode of transmission were considered in the analysis.

Ethical considerations

Since the study involved publicly available data from the Brazilian Ministry of Health, it was not submitted to a research ethics committee. The results were presented in an aggregated manner to ensure confidentiality and comply with Resolution 466/2012 of the National Health Council.

Statistical analysis

The data analysis involved descriptive statistics to summarize the demographic characteristics of HIV patients. Linear regression was applied to identify trends in HIV cases over time, and these trends are illustrated in the following figures.

Results and discussion

HIV in Southern Brazil

From 2011 to 2021, Southern Brazil recorded 87,025 diagnosed cases of HIV. Among the states, Rio Grande do Sul exhibited the highest number of cases throughout the analyzed period, accounting for 48% (n = 41,715) of the cases, followed by Santa Catarina with 27% (n = 23,495), and Paraná with 25% (n = 21,765) (Figure 1a). Figure 1a also presents the linear regression analysis, which reveals a general downward trend in the number of notifications across all three states. In the period from 2011 to 2021, the incidence of HIV per 100,000 inhabitants was 383 in Rio Grande do Sul, 308 in Santa Catarina, and 190 in Paraná (Figure 1b).

In 2021, in terms of AIDS detection rates, Rio Grande do Sul ranked third in the country, with 24.3 cases per 100,000 inhabitants. The leading states in this index were Amazonas (39.7) and Pará (24.3). Santa Catarina reported 23.4, and Paraná had 14.6 cases per 100,000 inhabitants. The national average was 16.5 (Brazil, 2022). The high rate of HIV in Rio Grande do Sul could be due to the high prevalence of injecting drug users in the state and the metropolitan region of Porto Alegre (Pereira et al., 2018).

The consistent decline in HIV notifications over the years suggests improvements in public health measures, disease prevention, and control strategies. However, the significant reduction observed during the COVID-19 pandemic warrants further investigation to understand the underlying causes and ensure accurate surveillance and reporting in the future. Several factors related to the pandemic could have contributed to this decline. The healthcare system overload placed extraordinary stress on healthcare systems, potentially diverting resources and attention away from routine health services and notifications. Changes in health-seeking behavior, driven by the fear of contracting COVID-19 and lockdown measures, may have led individuals to avoid healthcare facilities, resulting in fewer notifications (Rigotti et al., 2022). Additionally, the disruption of routine health services, including surveillance and reporting systems, could have led to

underreporting. Finally, public health measures such as enhanced hygiene practices, social distancing, and lockdowns may have reduced the transmission of other communicable diseases, leading to an overall decline in notifications (Rigotti et al., 2022).

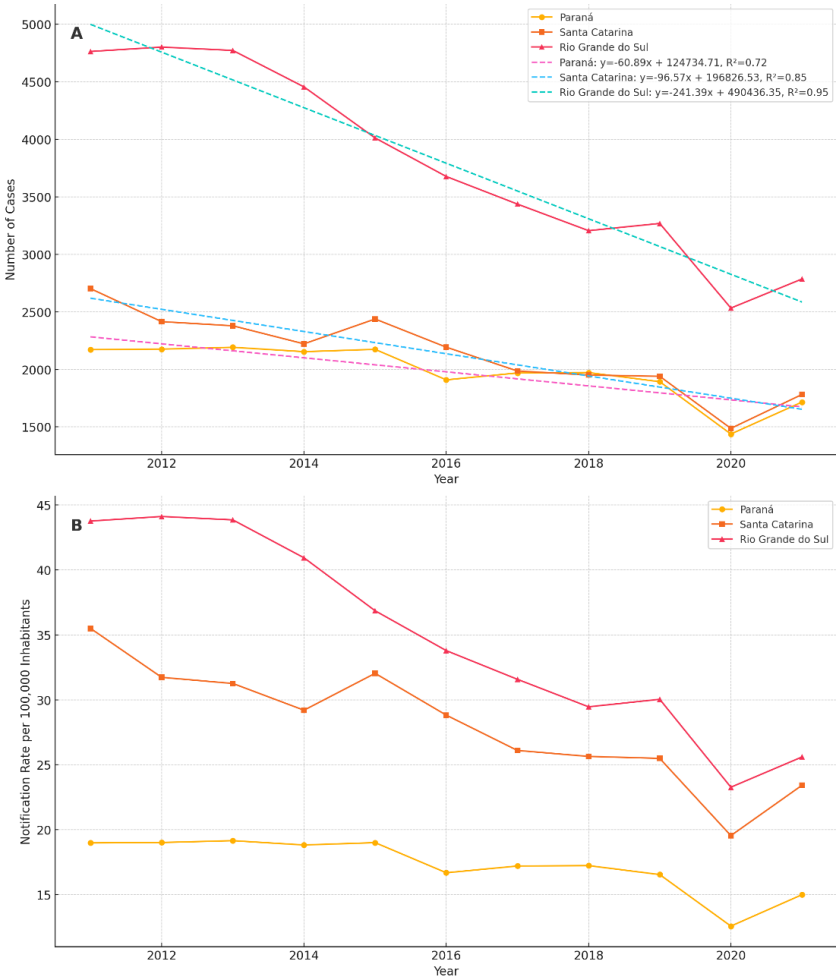

Figure 1. Number of HIV notification cases reported in DATASUS for Southern Brazil (A) and notification rate per 100,000 inhabitants in the same region (B) from 2011 to 2021.

HIV and gender of patients

Men accounted for 62% (n = 54,031) of these cases, and women represented 38% (n = 32,994) (Figure 2). A closer look at the data reveals a 26% (n = 1,471) reduction in cases among men and a more substantial reduction of 48% (n = 1,992) among women when comparing the first and last years examined.

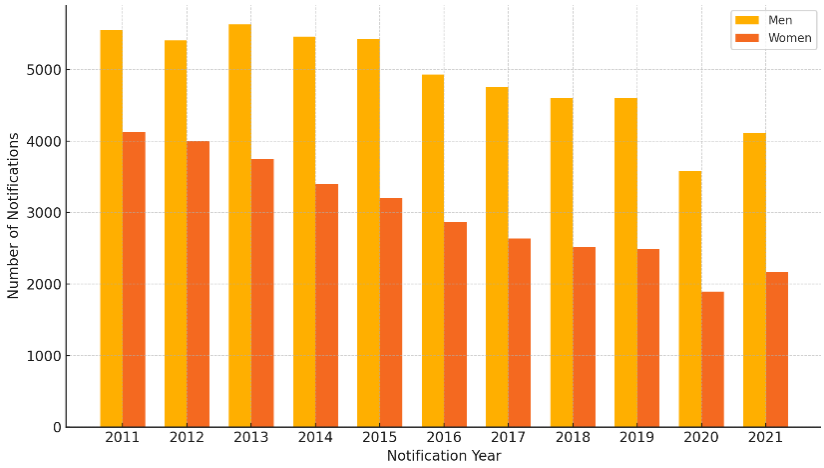

Figure 2. Number of HIV notification cases in men and women in Southern Brazil from 2011 to 2021.

The higher prevalence of HIV/AIDS cases in men is likely attributable to health-related factors elucidated in a prior study by Knauth et al. (2020). This research highlighted gender-based disparities in HIV diagnosis-seeking behaviors. Women have been actively incorporated into prevention strategies since the establishment of the Comprehensive Women's Health Care Program in 1983, which has long provided specialized care and attention to women across various health contexts (Brazil, 2008). In contrast, the National Policy for Comprehensive Men's Health Care was introduced by the Brazilian Ministry of Health for the male population only in 2009. Although HIV/AIDS is supposed to be a priority in men's health, public health services have not adequately addressed these issues in practice (Knauth et al., 2012), contributing to the observed male predominance in HIV/AIDS cases.

Studies suggest that men present higher HIV rates due to behavioral factors such as commercial sex, beliefs about HIV severity, and condom usage influenced by norms of masculinity. Biological factors also play a role, including the presence of genital ulcers and higher viral loads among certain groups (Barbosa & Koyama, 2008; Cameron et al., 1989; da Cruz et al., 2021).

A study conducted at an HIV center in London revealed that 98% of women reported having had one or no sexual partners in the preceding three months, whereas 57% of men who have sex with men reported two or more partners. Only 28% of women, 53% of heterosexual men, and 29% of men who have sex with men reported consistently using a condom for vaginal or anal intercourse. Positive diagnoses for sexually transmitted infections were found in 17.5% of women, 20% of heterosexual men, and 49% of men who have sex with men. Only 20% of patients reported consistently using a condom, while 38% did so inconsistently (Hamlyn et al., 2009). This data highlights the importance of behavior in the dissemination of the virus. The low use of condoms among women and the high prevalence of multiple sexual partners among men who have sex with men indicate that tailored prevention strategies may be more effective. Prevention programs that consider the specific dynamics of each group, including awareness campaigns, condom distribution, and facilitated access to sexual health services, can reduce the incidence of sexually transmitted infections.

HIV and race/ethnicity

Regarding race/ethnicity, the descriptive analysis of the notification data shows that white people had the highest average number of notifications, with 4,006 ± 1,319 cases, indicating considerable variability over the years (Figure 3). Mixed-race individuals had an average of 695 ± 144 cases, while black people averaged 591 ± 145 cases, reflecting more stability compared to the white population. Indigenous people presented the lowest notification counts, below 20 cases per year. The higher prevalence among white individuals is likely influenced by the South region's overall demographic composition, where 72.8% of the population identifies as white (Brazilian Institute of Geography and Statistics [IBGE], 2023). However, it is important to highlight that a substantial number of cases lack patient race/ethnicity data.

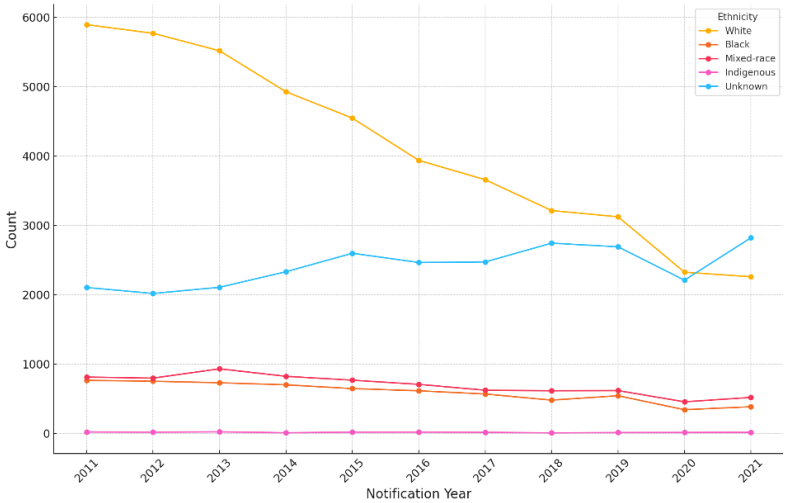

Figure 3. Number of HIV notification cases by race-ethnicity in Southern Brazil from 2011 to 2021.

The study of the historical records of AIDS in the Brazilian state of Ceará indicates that the highest rates (80%) occurred among the mixed-race population during the period from 2001 to 2011, followed by white individuals (Pedrosa et al., 2015). This result reflects the population of the state of Ceará, which is predominantly (64.7%)

mixed-race (IBGE, 2023). Similar trends were observed in the Center-West Region of the country (Pereira et al., 2011). In Brazil, several studies have documented limited access to health services among poor populations (Almeida et al., 2000) and higher morbidity and mortality rates among black and/or mixed-race individuals compared to the white population (Barros et al., 2001; Martins & Tanaka, 2000; Olinto & Olinto, 2000).

HIV and age distribution

Examining age groups within the 87,025 cases documented by DATASUS, individuals under 10 years old accounted for 1.02% (n = 896) of diagnoses (Figure 4). The group aged 11 to 19 years, including children and adolescents, and adults aged 20 to 34 years represented 2.31% (n = 2,015) and 35.8% (n = 31,209) of diagnosed cases, respectively. Notably, the age group of 35 to 49 years exhibited the highest diagnosis rate over the analyzed period, comprising 38.7% (n = 33,713), while the remaining 22% (n = 19,199) affected individuals aged 50 and older.

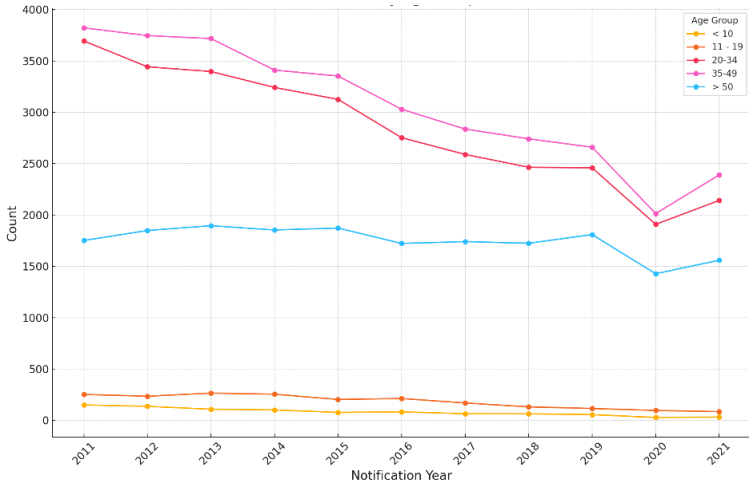

Figure 4. Number of HIV notification cases by age group in Southern Brazil from 2011 to 2021.

A study about social and sexual behaviors among Brazilian young people aged 15 to 24 years old revealed that, among the 26,010 participants, 65.7% reported drug use and 13% reported both drug use and engagement in commercial sex. Overall, 53.8% reported condom use at their last sexual intercourse and 7.9% reported symptoms of sexually transmitted infections in the last 12 months (Dourado, 2017). Once again, these findings underscore the essential role of behavioral factors in determining the risk of infection.

HIV and schooling

Out of the total population of 87,025 diagnosed cases, it is noteworthy that information about education levels was available for only 49,648 cases (Figure 5). Within this subset, illiterate individuals accounted for 1.6% (n = 795), while those with elementary education represented 54% (n = 26,879). Those with high school education comprised approximately 30% (n = 14,978) of the cases, and those with higher education represented nearly 14% (n = 9,669).

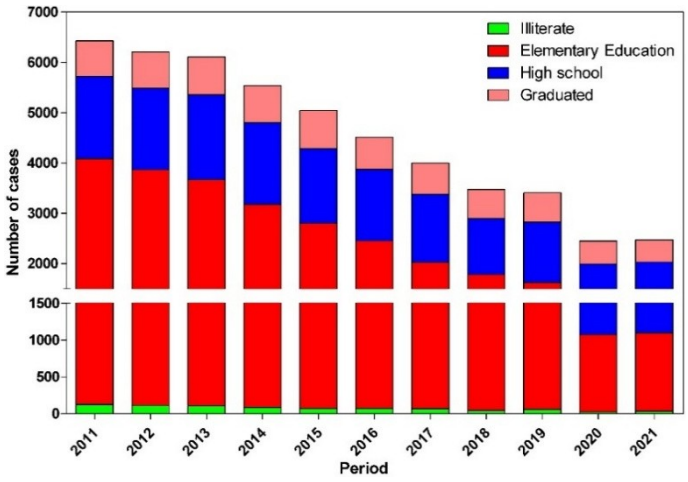

Figure 5. Number of HIV notification cases by schooling among the Southern population from 2011 to 2021.

Low levels of education are associated with poorer living standards, inadequate housing and nutrition, limited transportation options, and restricted access to healthcare services, along with experiences of social discrimination (Oliva, 2010). In various regions of Brazil, survival rates and adherence to antiretroviral therapy have been correlated with lower levels of education, with these populations exhibiting not only higher mortality rates but also lower treatment adherence (Silva et al., 2015; Tancredi & Waldman, 2014).

HIV by state

Across the three states, a general decline in HIV notifications was observed over the years (Figure 6). In Paraná, notifications for males decreased from a peak of 1,473 in 2015 to 1,231 in 2021, while notifications for females presented a sharper decline from 870 in 2011 to 484 in 2021. Santa Catarina followed a similar trend with male notifications peaking at 1,567 in 2015, then dropping to 1,189 by 2021. Female notifications decreased from 1,133 in 2011 to 593 in 2021. Rio Grande do Sul showed a noticeable decline in both male and female notifications from their respective peaks of 2,734 and 2,166 in 2013 to 1,696 and 1,090 in 2021. There is a consistent gender disparity in notifications across all three states, with male notifications being higher than female notifications every year. This trend might suggest a higher prevalence or reporting rates among males.

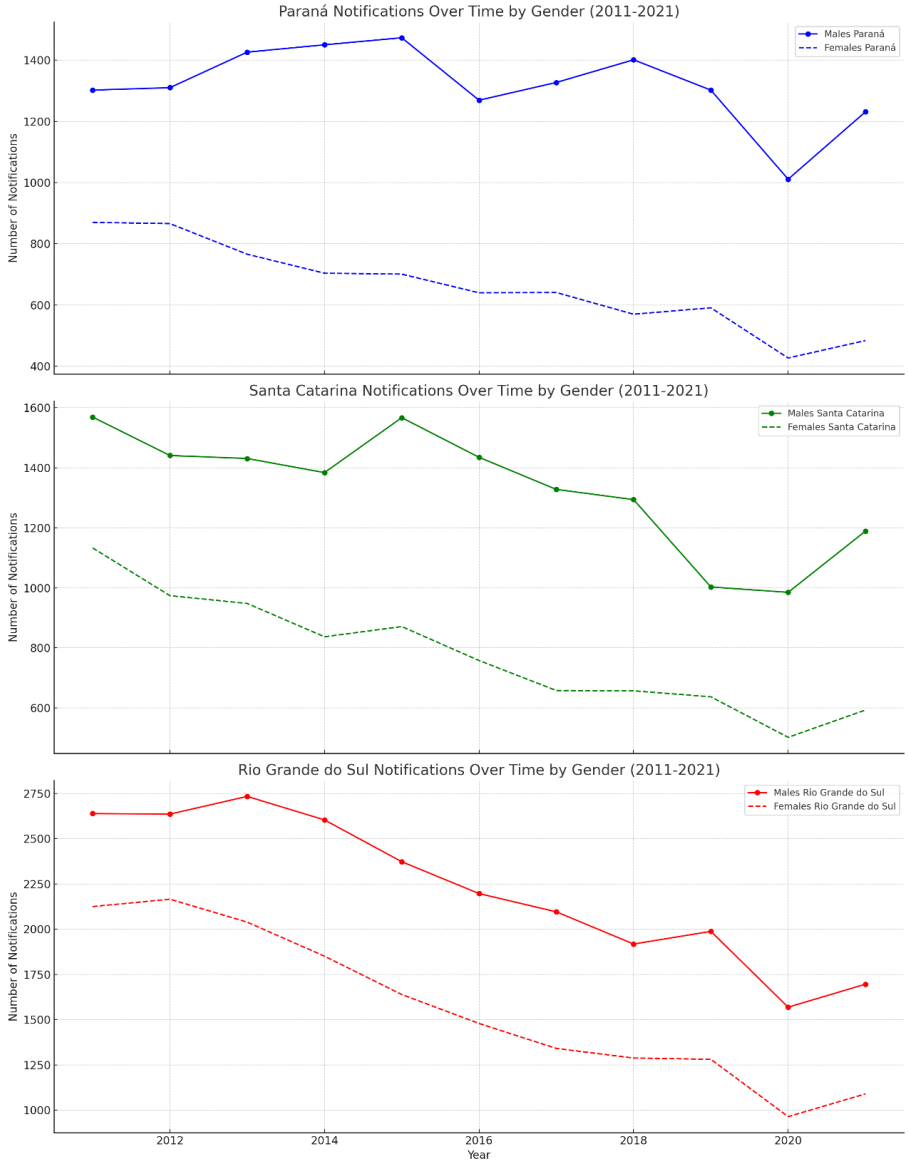

Figure 6. Number of HIV notification cases by gender in the population from the states of Paraná, Santa Catarina, and Rio Grande do Sul from 2011 to 2021.

A study evaluating the impact of the COVID-19 pandemic on HIV/AIDS diagnoses and mortality rates in Brazil throughout 2020 and 2021 found a decrease of 22.4% in HIV/AIDS diagnoses in 2020 and a further 9.8%

reduction in 2021 (Andrade et al., 2023). However, there was an increase in the late diagnoses of AIDS-related deaths, with rates rising by 6.9% in 2020 and 13.9% in 2021 (Andrade et al., 2023).

Figure 7 provides a detailed view of HIV notification cases by race/ethnicity in the states of Paraná, Santa Catarina, and Rio Grande do Sul from 2011 to 2021. In Paraná, the white population had the highest number of notifications over the years, showing a significant downward trend after 2014, with a decrease from 1,230 in 2011 to 626 in 2021. Although the number of notifications for the black population fluctuated, they varied within a smaller range, between 56 and 111. The mixed-race population presented an increase in notifications until 2013, followed by a gradual decline, while those of the indigenous population remained low (lower than 5 per year) and stable. It is important to mention that 7,600 patients were not classified by race/ethnicity and were categorized as 'unknown,' with significant variations, especially in 2015 and 2018.

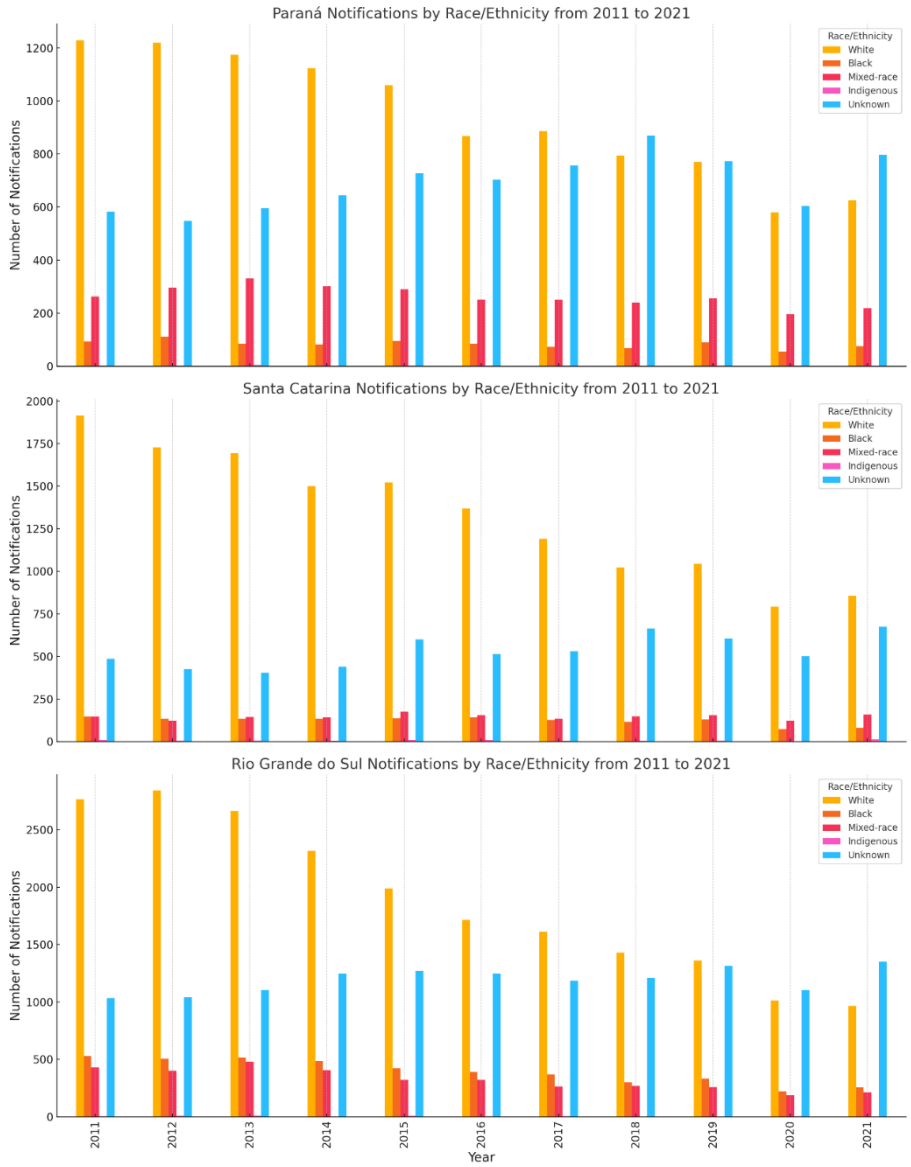

Figure 7. Number of HIV notification cases in the population from the states of Paraná, Santa Catarina, and Rio Grande do Sul by race/ethnicity from 2011 to 2021.

In Santa Catarina (Figure 7), the pattern is similar, with the white population leading in the number of notifications (n = 14,636), followed by mixed-race individuals (n = 1,597). The black and indigenous populations showed lower and relatively stable numbers, with a total of 1,349 and 70 cases in 10 years, respectively. Notifications among the white population declined from 1,916 in 2011 to 857 in 2021, whereas among the black population they remained relatively stable, with minor fluctuations between 72 and 145. Although the indigenous population's numbers were low, there were slight increases in some years, peaking at 12 in 2021. It is worth noting that 5,843 cases in Santa Catarina were not classified by race/ethnicity.

In Rio Grande do Sul (Figure 7), the white population also had the highest number of notifications (n = 20,670), with a declining trend similar to that of other states. The black, mixed-race, and indigenous populations had fewer notifications, with 4,328, 3,552, and 57, respectively. Specifically, the notifications for the white population decreased from 2,765 in 2011 to 964 in 2021. The number for the black population showed some fluctuation, ranging from 221 to 529. The mixed-race population's trend was relatively stable, with a slight decrease over the years, and notifications among the indigenous population remained consistently low (less than 11 cases per year), with minor variations. A significant number of cases (13,108) in this state were not segregated by patient race/ethnicity.

Figure 8 illustrates HIV notification cases by age group in Paraná, Santa Catarina, and Rio Grande do Sul from 2011 to 2021. In Paraná, the 20-49 age group had the highest number of cases, peaking in 2011 with 1,716 cases and showing a gradual decline to 1,279 cases in 2021. All age groups in Paraná experienced an overall decline in cases over the decade. Similarly, in Santa Catarina, the 20-49 age group had the highest annual case numbers, with a peak of 2,128 cases in 2011, and a noticeable overall decline across all age groups over the years. In Rio Grande do Sul, the 20-49 age group had the highest number of cases, peaking at 3,662 in 2012, with a steady decline across all age groups from 2012 onwards. Overall, the 20-49 age group had the highest number of cases in all three states, indicating higher vulnerability or exposure in this demographic group.

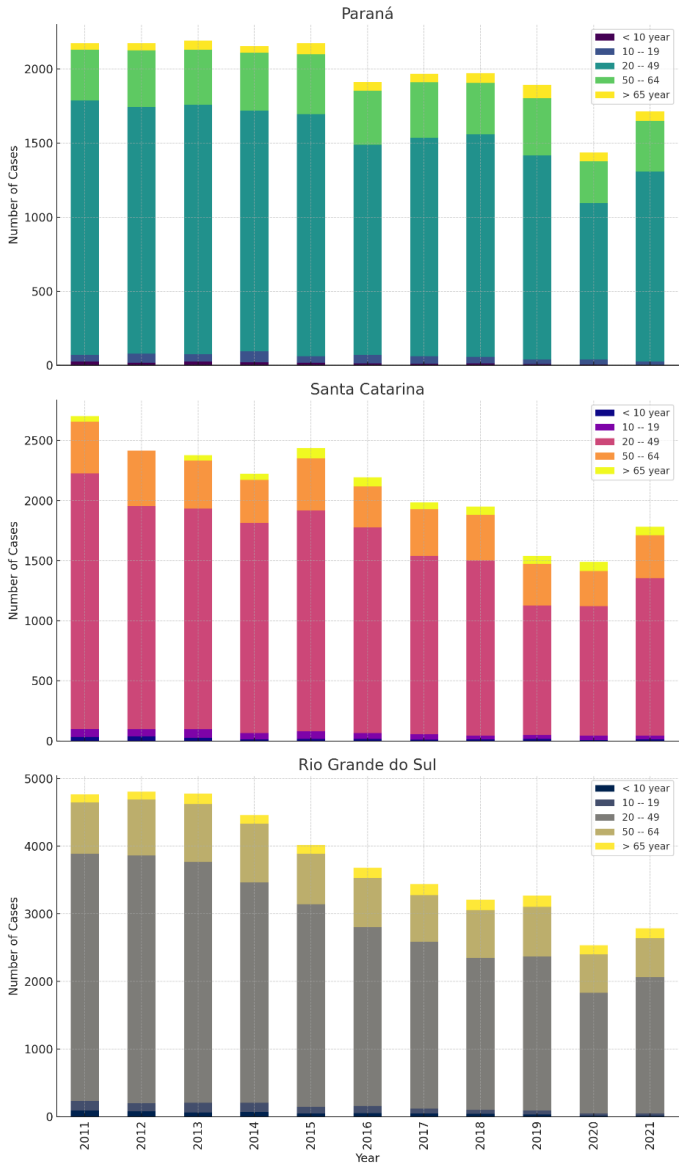

Figure 8. Number of HIV notification cases in the states of Paraná, Santa Catarina, and Rio Grande do Sul from 2011 to 2021.

Figure 9 illustrates the HIV transmission routes reported in Paraná, Santa Catarina, and Rio Grande do Sul from 2011 to 2021. In Paraná, the heterosexual transmission route presented the highest number of cases

each year, with a peak of 1,138 cases in 2012 and a decline to 483 cases in 2021. Homosexual transmission also represented a significant portion of cases, with a peak of 342 cases in 2019 and fluctuations over the years. However, the 'unknown' category showed significant variability, notably peaking at 146 cases in 2012.

In Santa Catarina, heterosexual intercourse transmission also dominated, peaking at 1,586 cases in 2011 and gradually declining to 664 cases in 2021. Homosexual intercourse transmission was the second most reported route, with a peak of 408 cases in 2015. The injectable drug use route showed a significant drop from 114 cases in 2011 to 21 cases in 2021. The 'unknown' category fluctuated, peaking at 108 cases in 2013.

In Rio Grande do Sul, heterosexual intercourse transmission was the most prevalent route, peaking at 2,497 cases in 2012 and declining to 937 cases in 2021. The homosexual intercourse transmission route also presented a decrease from 380 cases in 2012 to 181 cases in 2021. Notably, the injectable drug category also presented a significant reduction over the years. The 'unknown' category consistently had high numbers, peaking at 721 cases in 2012 and declining to 312 cases by 2021.

Overall, heterosexual intercourse transmission remains the predominant mode in all three states, with a general decline in cases across most categories over the years, highlighting the possible effectiveness of public health interventions. The fluctuations in the 'unknown' category suggest possible variations in reporting or data collection practices. The injectable drug transmission route also presented a significant reduction, possibly reflecting effective programs and education on drug use. These results underscore the importance of ongoing and improved interventions, consistent reporting mechanisms, as well as the need for more robust and standardized data collection practices to better understand and mitigate the different transmission routes.

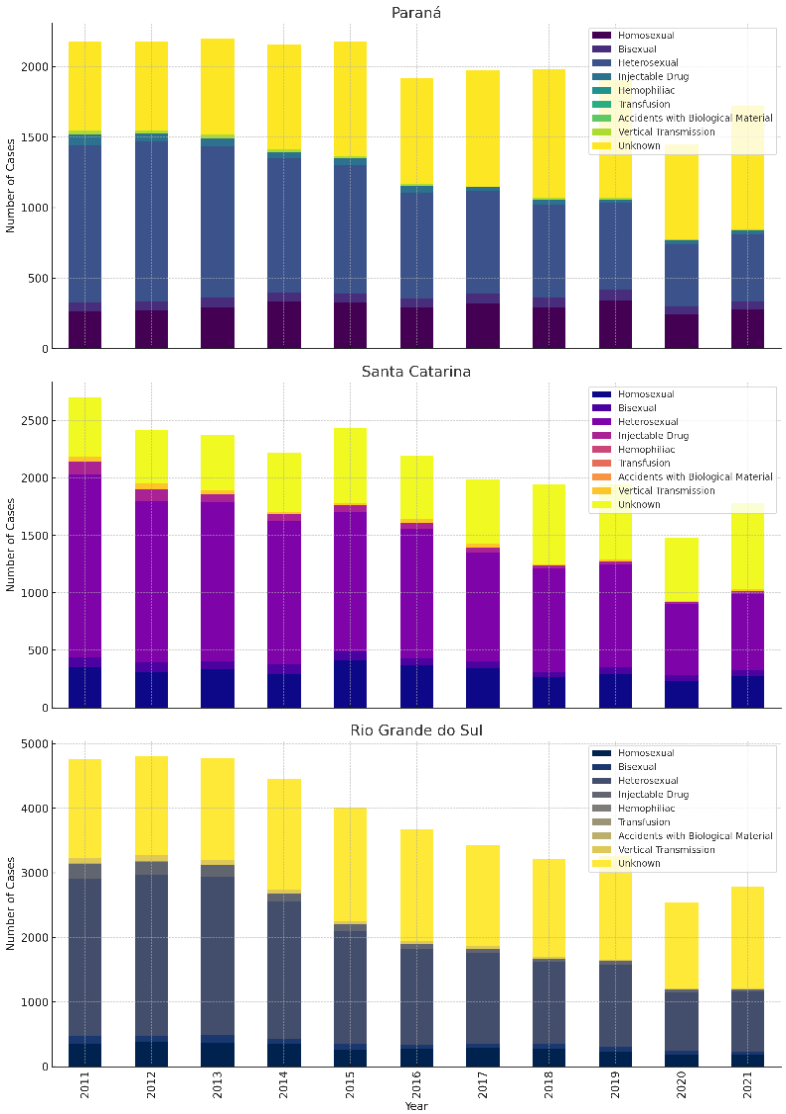

Figure 9. Number of HIV notification cases by transmission route in the states of Paraná, Santa Catarina, and Rio Grande do Sul from 2011 to 2021.

Conclusion

These findings highlight the importance of targeted and socially sensitive public health interventions. The gender disparity in disease prevalence highlights the need for differentiated approaches that consider gender dynamics and social determinants of health. Additionally, the concentration of cases among middle-aged adults emphasizes the importance of ongoing education on prevention and testing across all age groups. The data also suggests the need for improved data collection and reporting methods to better understand and address the factors contributing to HIV transmission.

Despite considerable advances in combating HIV, the virus continues to circulate and be transmitted. The persistence of the disease underscores the importance of holistic and inclusive approaches that address not only behavioral factors but also the structural systems perpetuating inequality. Only through collaborative and comprehensive efforts can we achieve a significant reduction in the burden of HIV and promote the health and well-being of all affected communities.

Data availability statement

The data that support the findings of this study are available from the senior author upon reasonable request.

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