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Trends in Reported HIV/AIDS Cases and Epidemiological Characteristics of HIV/AIDS in Elderly Individuals in the State of Maranhão

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Abstract

Objective: To identify trends in reported HIV/AIDS cases and annual reporting rates based on surveillance data, and to describe the epidemiological characteristics of HIV/AIDS among older adults in the state of Maranhão.

Methods: This descriptive epidemiological study employed a quantitative approach using secondary data from 2014 to 2023. Data were collected in February 2024 from the HIV/AIDS Notifiable Diseases Information System. The variables included year of diagnosis, age group, sex, race/skin color, education level, and exposure category. Annual rates of reported HIV/AIDS cases were calculated for each year, and temporal trend analysis was performed using Prais–Winsten regression. Epidemiological characteristics were examined using descriptive statistics.

Results: A total of 346 cases were reported. The highest annual reporting rate was recorded in 2016 (7.47 per 100,000 older adults), while the lowest was observed in 2023 (1.49 per 100,000 older adults). Temporal trend analysis indicated a statistically significant decrease in the annual reporting rate of HIV/AIDS cases among older adults in the state ($p < 0.05$). Most cases occurred among males (67.9%), individuals aged 60–69 years (75.1%), those of mixed race/skin color (64.2%), and heterosexual individuals (83%).

Conclusion: The annual reporting rate of HIV/AIDS cases among older adults declined during the study period. However, the epidemiological characteristics highlight the need to improve awareness and address existing taboos by openly discussing sexuality and promoting all forms of prevention. These efforts are essential to ensuring healthy and safe aging through shared responsibility.

Keywords

human immunodeficiency virus; acquired immunodeficiency syndrome; HIV in older adults; HIV prevalence; epidemiological surveillance

1. Introduction

According to estimates from the Global Burden of Disease (GBD) study, HIV/AIDS remains a major global public health challenge. In 2021, the global incidence of HIV/AIDS reached approximately 1.65 million cases

(95% uncertainty interval [UI]: 1.48–1.82 million). Between 1990 and 2021, the age-standardized incidence rate (ASIR) showed a decreasing global trend, with an estimated annual percentage change (EAPC) of −0.14% (95% UI: −0.16 to −0.12). The highest age-standardized incidence, detection, and mortality rates were observed in regions with lower Socio-demographic Index (SDI), particularly in sub-Saharan Africa, demonstrating persistent inequalities in the global distribution of HIV/AIDS burden. Although global estimates demonstrate progress in controlling the epidemic, HIV/AIDS continues to affect diverse populations, including older adults, whose epidemiological characteristics require specific attention due to demographic aging and changes in disease patterns [1].

In Brazil's current demographic scenario, the population aged 60 years and older exceeds 32 million people, representing approximately 15% of the country's total population. Projections for 2060 estimate that Brazilians will have an average life expectancy of up to 81 years, representing substantial progress compared with the beginning of the century, when life expectancy was approximately 70 years, according to the Brazilian Institute of Geography and Statistics (IBGE) [2].

Changes in the population structure, particularly population aging, present major challenges, especially in the healthcare sector. Addressing the specific needs of older adults, both in terms of healthcare and social integration, requires a broader and more sensitive approach from healthcare professionals and society as a whole [3].

Active and healthy aging involves maintaining physical, mental, and social capacities throughout life, enabling older adults to participate in society according to their preferences, abilities, and needs while receiving appropriate support when necessary [4].

Recent technological advances have contributed significantly to improving quality of life. These developments have provided older adults with access to treatments such as hormone replacement therapy and medications for erectile dysfunction, including sildenafil (Viagra), enabling this population to explore new possibilities for sexual activity. However, engaging in unsafe sexual practices may increase the risk of acquiring several infections, including Human Immunodeficiency Virus (HIV) infection and other sexually transmitted infections (STIs) [5–6].

Human Immunodeficiency Virus (HIV) infection and Acquired Immunodeficiency Syndrome (AIDS) represent distinct but interconnected epidemiological conditions. HIV infection refers to the presence of the virus in the host, whereas AIDS represents the advanced stage of infection characterized by severe immune dysfunction, particularly involving CD4+ T lymphocytes. Although antiretroviral therapy has substantially improved survival among people living with HIV, AIDS remains an important public health outcome associated with late diagnosis and inadequate treatment access. The virus replicates by integrating its genetic material into the DNA of these cells, allowing continuous viral replication and infection of new host cells [7]. HIV can be transmitted through unprotected sexual intercourse, sharing contaminated needles, transfusion of infected blood, mother-to-child transmission during pregnancy, childbirth, or breastfeeding, and the use of non-sterile instruments [8].

AIDS was recognized as a global epidemic in the early 1980s, following the identification of clusters of opportunistic infections and severe immunodeficiency among previously healthy individuals. Subsequent retrospective investigations provided evidence of HIV infections occurring before the formal recognition of AIDS, indicating that the virus had been circulating in human populations earlier. In Brazil, the first officially reported AIDS case occurred in 1980 in the state of São Paulo [9].

According to data from the Brazilian Ministry of Health, more than one million AIDS cases were reported in the country between 1980 and 2023. During the same period, more than 30,000 cases were recorded among individuals aged 60 years and older. These statistics underscore the importance of increasing awareness and strengthening access to healthcare services for the prevention, care, and treatment of this disease [10].

Studies conducted in different regions of Brazil have shown that many older adults maintain an active sexual life characterized by desire and pleasure. However, they frequently engage in unprotected sexual practices, possibly because they do not perceive themselves as being vulnerable to STIs, including HIV. Nevertheless, global data on the distribution of these infections across age groups challenge this perception, highlighting the importance of prevention strategies specifically targeting the older adult population [5,11–12].

Over the past decade, the prevalence of HIV/AIDS among older adults has attracted increasing scientific attention, reflecting growing concern regarding this age group. In the state of Maranhão, previous studies have described epidemiological characteristics of HIV infection among older adults; however, analyses based on reported HIV/AIDS cases over time remain limited. Considering the socioeconomic and healthcare inequalities observed among Brazilian regions, local investigations are essential because regional differences in access to health services, diagnostic capacity, and epidemiological surveillance may influence patterns of HIV/AIDS detection and notification. Therefore, understanding the temporal behavior and epidemiological characteristics of reported HIV/AIDS cases among older adults in Maranhão is essential to support targeted prevention strategies, improve healthcare planning, and strengthen actions directed toward this population. Consequently, the lack of such analyses limits a comprehensive understanding of the epidemiological situation [13–14].

Considering the increase in life expectancy and

evidence that many older adults remain sexually active throughout aging, understanding the dynamics of sexually transmitted infections in this age group has become essential [5,6]. Despite the relevance of this topic, studies focusing on HIV/AIDS among older adults remain scarce, particularly in regional settings such as Maranhão, where sociocultural factors and limited access to information and healthcare services may increase this population's vulnerability. Region-specific analyses can identify epidemiological patterns and support the development of more effective preventive strategies tailored to the unique characteristics of aging [4,6].

Brazil presents important regional inequalities in health conditions and access to healthcare services, with greater socioeconomic vulnerabilities historically observed in the North and Northeast regions. In this context, Maranhão presents specific challenges related to social determinants of health, healthcare accessibility, and epidemiological surveillance capacity, which may influence the diagnosis, notification, and management of HIV/AIDS cases. Therefore, regional analyses are essential to identify local epidemiological patterns and support public health strategies adapted to the specific needs of older adults in Maranhão [1-2].

Based on this context, the present study aimed to determine the annual rate of reported HIV/AIDS cases trend and describe the epidemiological characteristics of HIV/AIDS among older adults in the state of Maranhão, Brazil, from 2014 to 2023.

2. Materials and methods

This was a descriptive epidemiological study with a quantitative approach conducted in the state of Maranhão, located in northeastern Brazil. Secondary data were collected in February 2024 from the Notifiable Diseases Information System (SINAN), available through the database of the Department of Informatics of the Brazilian Unified Health System (DATASUS), using the publicly accessible TABNET generic tabulator [15-16].

The study included HIV/AIDS cases among individuals aged 60 years or older residing in Maranhão, Brazil, diagnosed between 2014 and 2023. Cases were selected according to the year of diagnosis, and each record was assigned to the corresponding calendar year. Duplicate records were identified and removed before the analysis to avoid overestimation of the number of reported cases.. The following variables were analyzed: age (60–69 years, 70–79 years, and 80 years or older), sex (male and female), race/skin color (White, Black, Asian, Brown, and unknown), educational level (illiterate, incomplete 1st–4th grade of elementary school, complete 4th grade of elementary school, incomplete 5th–8th grade of elementary school, complete elementary school, incomplete high school, complete high school, incomplete higher education, complete higher education, and unknown). The hierarchical exposure category (HEC), as defined in SINAN, was analyzed as an epidemiological classification of reported exposure categories, including homosexual, bisexual, heterosexual, shared use of injectable drugs, vertical transmission, and unknown. This classification reflects the information available in the surveillance system and does not provide detailed information regarding sexual practices, partner characteristics, or contextual factors associated with HIV transmission.

Population data were obtained in February 2024 from the Brazilian Institute of Geography and Statistics (IBGE) Automatic Recovery System (SIDRA) database [2].

The annual rate of reported HIV/AIDS cases among older adults was estimated by dividing the number of HIV/AIDS cases recorded in SINAN among individuals aged 60 years or older, classified according to the year of diagnosis, by the corresponding population of older adults residing in the state of Maranhão during the same year, as estimated by the Brazilian Institute of Geography and Statistics (IBGE). Duplicate records were identified and removed before the analysis to avoid overestimation of the number of reported cases. The resulting value was multiplied by a constant of 100,000 and expressed as the annual rate of reported HIV/AIDS cases per 100,000 older adults.

This indicator represents the occurrence of HIV/AIDS cases diagnosed and recorded by the surveillance system in relation to the older adult population for each year of the study period. Because the numerator was based on surveillance records of diagnosed and reported cases, this measure should be interpreted as a surveillance-based indicator of reported HIV/AIDS cases rather than a direct estimate of HIV/AIDS prevalence or the total number of individuals living with HIV/AIDS in the population.

As SINAN is a passive surveillance system, this indicator may be influenced by limitations inherent to notification databases, including possible underreporting, delayed notification, incomplete updating of historical records, and variations in the completeness of surveillance information over time. Therefore, temporal changes in reported cases should be interpreted with caution and considered in the context of the characteristics and limitations of surveillance-based data [4].

Epidemiological variables were analyzed using descriptive statistics and presented as absolute

and relative frequencies. Missing or unknown information recorded in SINAN was maintained as a specific category in the descriptive analysis, without imputation, to preserve the characteristics of the original surveillance database. The potential influence of missing information on the interpretation of variables with higher proportions of unknown records was considered in the discussion. Statistical analyses were performed using IBM SPSS Statistics version 24.0.

To determine the temporal trend in reported HIV/AIDS cases among older adults in the state of Maranhão, Prais–Winsten regression models were applied. The annual rates of reported HIV/AIDS cases were transformed using the natural logarithm before regression analysis. The presence of serial autocorrelation in the annual time-series data (2014–2023) was assessed using the Durbin–Watson test. When autocorrelation was identified, the Prais–Winsten model was used to correct first-order autocorrelation (AR(1)) and provide more reliable estimates of temporal trends.

The annual percentage change (APC) and its corresponding 95% confidence interval were calculated using the exponential transformation of the regression coefficient, according to the formula: $APC = (e\beta - 1) \times 100$. The confidence interval was obtained by applying the same transformation to the lower and upper limits of the regression coefficient. The model included year as the independent variable, and the estimated regression coefficient (β) was used to calculate the APC. The trend was classified as increasing, decreasing, or stationary according to the statistical significance of the regression coefficient, considering a significance level of 5%.

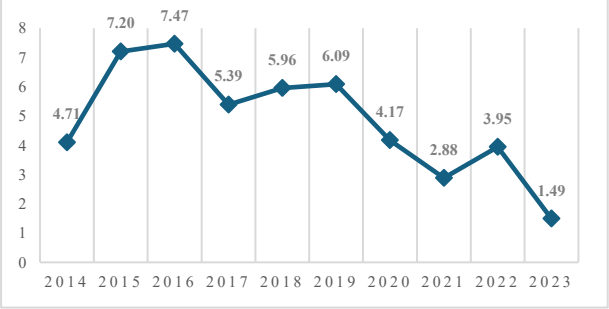
As a limitation inherent to the use of secondary surveillance data, the estimates derived from SINAN should be interpreted considering possible delays in notification, underreporting, and variations in the completeness of records. Additionally, because SINAN is based on passive surveillance, it does not provide active clinical follow-up of individuals previously reported, which may influence estimates based on reported cases over time.

This study used exclusively information obtained from publicly available databases, including DATASUS. Therefore, approval by a Research Ethics Committee was not required, in accordance with Brazilian National Health Council Resolution No. 510/2016, which exempts studies using publicly available data or public-domain databases without the possibility of individual identification from ethical review.

3. Results

Between 2014 and 2023, a total of 346 HIV/AIDS cases were reported in the state of Maranhão. The annual rate of reported HIV/AIDS cases ranged from 1.49 to 7.47 cases per 100,000 older adults during the study period. The highest annual rate was observed in 2016 (7.47 cases per 100,000 older adults), whereas the lowest was observed in 2023 (1.49 cases per 100,000 older adults). The annual variation in the rate of reported HIV/AIDS cases throughout the study period is presented in Figure 1.

Figure 1. Annual prevalence of reported HIV/AIDS cases among older adults per 100,000 older adults in Maranhão, Brazil, 2014–2023.



Source: Research data, 2024.

Regarding the temporal trend analysis, the results indicated a statistically significant decreasing trend in HIV/AIDS prevalence among older adults throughout the study period ($p < 0.05$). The model showed a moderate fit, with an adjusted R^2 of 0.521, suggesting that approximately 52.1% of the variation in prevalence was explained by time (Table 1). The Annual Percentage Change (APC) indicated an average annual reduction of 11.46% in HIV/AIDS prevalence among older adults in Maranhão over the study period, despite an increase observed during the initial years.

Table 1. Estimates from the Prais–Winsten regression model for the temporal trend in HIV/AIDS prevalence among older adults in Maranhão, Brazil, 2014–2023.

Variable	Coefficient (β)	95% CI	*p*-value
Intercept	2.1761	(1.716 – 2.636)	0.001
Time	- 0.1217	(-0.206 – - 0.037)	0.011

APC (%)	- 11.46%	(-18.62% – -3.63%)	-
Adjusted R^2	0.521	-	-

Source: Research data, 2024.

Regarding the epidemiological characteristics, Table 2 summarizes the sociodemographic and epidemiological profile of older adults diagnosed with HIV/AIDS during the study period. Individuals aged 60–69 years accounted for the largest proportion of reported cases (75.1%) during the study period. Most affected individuals were male (67.9%). Concerning the hierarchical exposure category (HEC), the heterosexual exposure category was the most frequently reported classification, accounting for 83.0% of the cases. Individuals identified as Brown (mixed race) represented the largest racial/skin color group (64.2%). Regarding educational attainment, the highest proportion of confirmed cases occurred among individuals with incomplete elementary education (1st–4th grades), representing 22.8% of the total. Individuals identified as Brown (mixed race) represented the largest racial/skin color group (64.2%). Regarding educational attainment, the highest proportion of confirmed cases occurred among individuals with incomplete elementary education (1st–4th grades), representing 22.8% of the total.

Missing or unknown data were observed for selected epidemiological characteristics, including hierarchical exposure category (8.4%), race/skin color (4.3%), and educational level (15.6%).

Table 2. Epidemiological characteristics of older adults with HIV/AIDS residing in and reported from the state of Maranhão, Brazil, 2014–2023.

Variable	**N**	**(%)**
Age group		
60–69 years	260	75.1
70–79 years	68	19.7
≥80 years	18	5.2
Sex		
Male	235	67.9
Female	111	32.1
Hierarchical exposure category (HEC)		
Homosexual	18	5.2
Bisexual	7	2.0
Heterosexual	287	83.0
Injection drug use (IDU)[1]	1	0.3
Vertical transmission[2]	4	1.1
Unknown*	29	8.4
Race/Skin color		
White	48	13.9
Black	60	17.3
Asian	1	0.3
Brown (mixed race)	222	64.2
Unknown*	15	4.3
Educational level		
Illiterate	72	20.8
Incomplete elementary education (1st–4th grades)	79	22.8
Complete 4th grade of elementary education	17	5.0
Incomplete elementary education (5th–8th grades)	51	14.7
Complete elementary education	25	7.2
Incomplete high school	2	0.6
Complete high school	33	9.5
Incomplete higher education	2	0.6
Complete higher education	11	3.2
Unknown*	54	15.6
Total	**346**	**100.0**

[1] Injection drug use (IDU). [2] Vertical transmission.
*Unknown/missing information was maintained as a category and included in the descriptive analysis.
Source: Research data, 2024.

An additional limitation concerns the use of surveillance data extracted from SINAN in February 2024,

considering that the study period included cases diagnosed until December 2023. Surveillance databases may undergo continuous updating, and more recent years may be more susceptible to incomplete recording at the time of data extraction. Although duplicate records were removed, the available surveillance data do not allow a direct estimation of all individuals living with HIV/AIDS in the population. Therefore, the annual indicators presented in this study should be interpreted as rates of reported HIV/AIDS cases identified by the surveillance system, rather than as population prevalence estimates. .

4. Discussion

The present study identified an increase in reported HIV/AIDS cases among older adults during 2015 and 2016, reaching 7.20 and 7.47 cases per 100,000 older adults, respectively. This increase should be interpreted cautiously, as surveillance-based indicators may reflect changes in diagnosis, access to testing, healthcare utilization, and notification practices, in addition to possible changes in HIV transmission dynamics. Previous studies have demonstrated increasing trends in HIV/AIDS indicators among older adults in Brazil, highlighting that factors such as unprotected sexual practices, limited access to information specifically targeted to this age group, and low perceived risk of infection may contribute to vulnerability in this population [15, 17–18].

Although the Prais–Winsten regression demonstrated a statistically significant decreasing trend in reported HIV/AIDS cases among older adults, the adjusted R^2 value (0.521) indicates that part of the variability observed over time was not explained solely by the temporal component. This unexplained variation may be influenced by external factors not evaluated in the present study, including changes in HIV testing strategies, local prevention campaigns, healthcare access, clinical practices related to diagnosis, reporting patterns among healthcare professionals, and possible fluctuations in underreporting within surveillance systems. Therefore, the observed decline should be interpreted cautiously, as it may reflect a combination of epidemiological changes and variations in diagnosis and notification processes [3,10].

The Prais–Winsten regression identified a statistically significant decreasing trend in the annual rate of reported HIV/AIDS cases among older adults in Maranhão between 2014 and 2023 (APC = −11.46%; 95% CI: −18.62% to −3.63%; p = 0.011). This finding indicates that the surveillance-based rate of HIV/AIDS cases diagnosed and recorded during the study period decreased over time. However, this decline should be interpreted with caution because the indicator analyzed was based on reported cases recorded in the surveillance system and does not represent a direct estimate of the total number of people living with HIV/AIDS. Therefore, the observed reduction in reported cases should not be interpreted as a confirmed decrease in HIV/AIDS prevalence among older adults in Maranhão.

Several factors may influence temporal variations in reported HIV/AIDS cases, including changes in access to HIV testing, diagnostic practices, healthcare utilization, case detection, and the completeness and timeliness of surveillance records. Thus, the decreasing trend observed in this study may reflect changes in the underlying epidemiological scenario, changes in the identification and reporting of cases, or a combination of these factors. However, the present study did not evaluate testing coverage, diagnostic delays, or notification completeness over time; therefore, these factors cannot be considered definitive explanations for the observed decline. They should instead be considered relevant aspects when interpreting surveillance-based temporal trends [7].

The significant decreasing trend observed in reported HIV/AIDS cases among older adults (APC = −11.46%) should be interpreted with caution. Although improvements in prevention strategies, expansion of HIV testing, and advances in clinical management may have contributed to changes in the epidemiological scenario, the reduction observed in surveillance data may also reflect variations in diagnosis and notification processes. During the COVID-19 pandemic period (2020–2023), healthcare systems experienced disruptions that affected several routine services, including screening, diagnosis, and follow-up activities. Therefore, the observed decline may represent a combination of epidemiological changes and variations in surveillance sensitivity rather than a direct reduction in HIV transmission alone [3,8,10,17].

The findings indicate that HIV/AIDS cases occurred predominantly among individuals aged 60–69 years. Similar results have been reported in studies conducted in the Brazilian states of Sergipe and Piauí, where 64.9% of cases were concentrated within the same age group [19–20]. Conversely, the proportion of reported cases decreased among individuals aged 70–79 years (19.7%) and those aged 80 years or older (5.2%). These findings indicate that reported HIV/AIDS cases were more concentrated among individuals aged 60–69 years; however, they do not establish an age-related risk gradient, since age-specific population denominators were not evaluated.This decline may be associated with several factors, including reduced self-esteem, loss of a sexual partner, decreased libido, and the onset of common age-related health conditions such as erectile dysfunction, cardiovascular diseases, and benign prostatic hyperplasia [21–22].

In the present study, males accounted for the majority of HIV/AIDS cases (67.9%). A study conducted in

the state of São Paulo reported similar findings, emphasizing the higher occurrence of HIV/AIDS among older men. This pattern may be related to lower acceptance of condom use within this population, influenced by factors such as reduced sexual sensitivity, concerns about erectile function, and refusal to use condoms due to monogamous relationships or having a stable partner [9].

Despite the higher number of cases among men, stigma surrounding HIV/AIDS remains prevalent. Many older men have difficulty accepting a positive diagnosis because they continue to associate HIV infection primarily with sex workers, men who have sex with men, and people who inject drugs [23].

With respect to the hierarchical exposure category (HEC), heterosexual exposure was the most frequently reported classification, accounting for 83.0% of reported cases.This finding may reflect the widespread misconception that sexually transmitted infections, including HIV/AIDS, primarily affect younger populations. Furthermore, inadequate communication by some healthcare professionals, often characterized by insensitive or inaccessible language, may cause discomfort among older patients when discussing sexual health. Consequently, preventive interventions targeting this age group become more difficult to implement, and discussions about sexual health frequently occur only after diagnosis, when counseling focuses mainly on preventing transmission to sexual partners [24–27].

Regarding race/skin color, individuals identified as Brown (mixed race) accounted for the highest proportion of reported cases (64.2%). Similar findings have been reported in studies conducted across different regions of Brazil, where Brown individuals consistently represented the largest proportion of people living with HIV/AIDS [3,13,28]. It is important to note that, according to the 2010 and 2022 Brazilian population censuses, the proportion of individuals self-identifying as Brown increased by 11.9% nationwide [2]. Nevertheless, race/skin color is a self-reported variable, and inaccuracies may occur if healthcare professionals misinterpret or incorrectly record an individual's self-identification [13,28].

The higher occurrence of HIV/AIDS among Brown individuals observed in this study is consistent with national epidemiological data. According to the 2023 Black Population Health Epidemiological Bulletin, Black individuals, particularly those who identify as Brown, are disproportionately affected by new HIV infections and progression to AIDS. This disparity is evident across multiple age groups and population subgroups, including young people, older adults, pregnant women, and Black women, highlighting the intersection of social vulnerability, structural racism, and unequal access to prevention and healthcare services [28].

Similar findings have been reported among older adults in Brazil, with lower educational levels frequently observed among individuals affected by HIV/AIDS. Studies assessing HIV/AIDS knowledge among older adults also highlight the importance of strengthening health education strategies focused on prevention and awareness [29]. Older adults with lower educational attainment often retain outdated perceptions of HIV infection, associating the disease with drug use, promiscuity, or even divine punishment [6].

With respect to missing information, unknown values were identified for the hierarchical exposure category (8.4%), race/skin color (4.3%), and educational level (15.6%). Previous studies have likewise reported high levels of underreporting and incomplete notification records [6,30–31]. The presence of missing data represents an important limitation, as it compromises the comprehensive assessment of the current epidemiological scenario.

The epidemiological profile of HIV/AIDS among older adults in Maranhão should be interpreted considering the regional and structural characteristics of the state. Maranhão, located in the Northeast region of Brazil, presents important socioeconomic and healthcare inequalities, including differences in the availability and organization of health services among municipalities. These disparities may influence access to HIV testing, diagnosis, clinical follow-up, and the completeness of notification records. Therefore, variations observed in surveillance data may reflect not only epidemiological differences but also local healthcare infrastructure and surveillance capacity. Strengthening decentralized strategies within primary healthcare services may contribute to earlier diagnosis and improved monitoring of HIV/AIDS among older adults in the state [2,10].

The persistent underreporting of HIV/AIDS cases in Brazil compromises the accuracy of epidemiological statistics and negatively affects the planning of prevention strategies, treatment programs, control measures for new infections, and long-term follow-up of diagnosed individuals. Improving healthcare professionals' knowledge regarding HIV/AIDS surveillance is essential to ensure accurate data collection and proper completion of notification forms, thereby increasing awareness of the importance of high-quality epidemiological information [32].

The findings of the present study highlight several public health needs, particularly in light of the identified limitations. Improving data collection through the training of healthcare professionals and the implementation of more rigorous and standardized reporting systems is essential. Furthermore, strengthening public health policies by developing strategies that expand access to and appropriate use of healthcare services is crucial, with particular emphasis on educational campaigns specifically targeting older adults. Such initiatives should provide clear information on HIV prevention and the correct use of condoms, contributing to stigma reduction and increased awareness.

The use of SINAN/DATASUS surveillance data represents an important source for monitoring HIV/AIDS patterns; however, these data are subject to limitations inherent to passive notification systems. Possible delays in reporting, underdiagnosis, underreporting, and differences in the completeness of recorded information may affect the observed trends. Therefore, the findings should be interpreted as patterns of reported HIV/AIDS cases based on surveillance data rather than as a direct measure of the absolute clinical prevalence of infection in the population.

Furthermore, because SINAN is not an active clinical follow-up system, annual estimates may be influenced by the persistence of historical notifications and the absence of individual-level linkage with mortality databases. Consequently, the results should not be interpreted as an absolute estimate of the number of individuals currently living with HIV/AIDS in Maranhão, but rather as temporal patterns of reported cases identified through the surveillance system.

The presence of incomplete information in surveillance databases also represents an important limitation. In this study, variables such as educational level and hierarchical exposure category presented missing records, which may affect the precision of the distribution of some categories, particularly those with smaller frequencies, such as injection drug use and vertical transmission. However, unknown information was retained as a category rather than excluded or imputed, allowing the results to reflect the completeness characteristics of the original SINAN database.

Finally, the interpretation of the hierarchical exposure category should be considered with caution. Although heterosexual exposure represented the most frequently reported category in this study, this classification reflects the categories available in SINAN and does not capture detailed information regarding sexual practices, partner characteristics, gender dynamics, or contextual aspects of HIV transmission. Therefore, these findings should be interpreted as patterns of reported exposure categories rather than as a complete characterization of transmission mechanisms among older adults.

5. Conclusions

An increase in HIV/AIDS prevalence rates was observed in 2015 and 2016, reaching 7.20 and 7.47 cases per 100,000 older adults, respectively, followed by a decline to 1.49 cases per 100,000 older adults in 2023. Overall, the temporal trend in HIV/AIDS prevalence among older adults was decreasing throughout the study period. Regarding the epidemiological profile, most reported cases occurred among males aged 60–69 years, with low educational attainment, self-identified as Brown (mixed race), and with heterosexual exposure being the most frequently reported hierarchical exposure category. However, the study also identified a substantial proportion of missing or unknown information in the hierarchical exposure category (HEC), race/skin color, and educational level variables, highlighting the need to improve data collection and notification processes to achieve a more comprehensive and accurate understanding of the HIV/AIDS epidemiological scenario among older adults.

These findings highlight the importance of strengthening HIV/AIDS prevention, diagnosis, and monitoring strategies directed toward older adults in Maranhão. Primary healthcare services should incorporate routine approaches to sexual health among older adults, including risk assessment, access to HIV testing, counseling, prevention strategies, and continuous education of healthcare professionals regarding sexuality and sexually transmitted infections in aging populations. In addition, strengthening surveillance practices and improving the completeness of notification records are essential to support more accurate epidemiological monitoring and the development of targeted public health interventions.

List of abbreviations

AIDS	Acquired Immunodeficiency Syndrome
APC	Annual Percentage Change
CD4	Cluster of Differentiation 4
CI	Confidence Interval
DATASUS	Department of Informatics of the Brazilian Unified Health System
HEC	Hierarchical Exposure Category
HIV	Human Immunodeficiency Virus
IBGE	Brazilian Institute of Geography and Statistics
IDU	Injection Drug Use
R^2	Coefficient of Determination
SIDRA	IBGE Automatic Recovery System
SINAN	Notifiable Diseases Information System
SPSS	Statistical Package for the Social Sciences
STIs	Sexually Transmitted Infections
TABNET	Public Health Data Tabulation System
CAPES	Coordination for the Improvement of Higher Education Personnel
CNPq	Brazilian National Council for Scientific and Technological Development
FAPEMA	Foundation for Research and Scientific and Technological Development Support of Maranhão
UFMA	Federal University of Maranhão
GBD	Global Burden of Disease
UI	Uncertainty Interval
ASIR	Age-Standardized Incidence Rate
EAPC	Estimated Annual Percentage Change
SDI	Sociodemographic Index

AR	Autoregressive term

Author Contributions

Conceptualization: Barros EA, Santos Neto M, Stabnow Santos F, Chaves ES; Methodology: Barros EA, Santos Neto M, Stabnow Santos F, Chaves ES; Investigation and Data curation: Chaves ES, Costa ACPJ, Pascoal LM, Morais JD, Santos LH, Andrade HLP, Siqueira LS; Formal analysis: Chaves ES, Costa ACPJ, Pascoal LM, Morais JD, Santos LH, Andrade HLP, Siqueira LS; Writing – original draft preparation: Chaves ES, Barros EA, Santos Neto M, Stabnow Santos F, Costa ACPJ, Pascoal LM; Writing – review and editing: Chaves ES, Barros EA, Santos Neto M, Stabnow Santos F, Costa ACPJ, Pascoal LM, Morais JD, Santos LH, Andrade HLP, Siqueira LS. All authors have read and agreed to the published version of the manuscript.

Availability of Data and Materials

The datasets analyzed during the current study are publicly available and can be accessed through the Brazilian Ministry of Health's Department of Informatics of the Unified Health System (DATASUS), via the Notifiable Diseases Information System (SINAN), at https://datasus.saude.gov.br/ and the TABNET platform (https://datasus.saude.gov.br/informacoes-de-saude-tabnet/). Population data used to calculate prevalence rates are publicly available from the Brazilian Institute of Geography and Statistics (IBGE) through the SIDRA database at https://sidra.ibge.gov.br/ [2]. No new datasets were generated during the current study.

Ethics Approval and Consent to Participate

Ethics committee approval and informed consent were not required for this study because it exclusively used secondary data obtained from publicly available, anonymized databases that do not allow the identification of individual participants. Therefore, according to Brazilian National Health Council Resolution No. 510/2016, research based exclusively on publicly available information or public-domain databases is exempt from review by a Research Ethics Committee.

Consent for Publication

Not applicable.

Conflict of Interest

The authors declare no conflicts of interest.

Funding

This research was funded by the Brazilian National Council for Scientific and Technological Development (CNPq) [grant number 407797/2023-8], Coordination for the Improvement of Higher Education Personnel – Brazil (CAPES) – Finance Code 001, and Foundation for Research and Scientific and Technological Development Support of Maranhão – FAPEMA.

Acknowledgments

We would like to thank the Maranhão Research and Scientific and Technological Development Support Foundation - FAPEMA, the National Council for Scientific and Technological Development, the Coordination for the Improvement of Higher Education Personnel, and the Federal University of Maranhão for their support of this research.

AI-declaration

The authors acknowledge the use of ChatGPT (OpenAI) exclusively as a language translation tool to translate the manuscript from Brazilian Portuguese into English. The scientific content, including the study conception, methodology, data analysis, interpretation of the results, and conclusions, was developed and critically reviewed entirely by the authors, who assume full responsibility for the final content of the manuscript.

References

[1] GBD 2023 HIV Collaborators. Global, regional, and national burden of HIV/AIDS, 1990–2023, with the estimated burden attributable to intimate partner violence and forecasted impacts of funding cuts through 2030: results from the Global Burden of Disease Study 2023. Lancet HIV. 2026. doi:10.1016/S2352-3018(26)00147-5.

[2] Brazilian Institute of Geography and Statistics (IBGE). Estimated resident population. Available from: https://sidra.ibge.gov.br. Accessed June 20, 2024.

[3] Aguiar TS, Fonseca MC, Santos MC, Nicoletti GP, Alcoforado DSG, Santos SCD, et al. Perfil epidemiológico do HIV/AIDS no Brasil baseado em dados do DataSUS no ano de 2021. Res Soc Dev. 2022;11(3):e4311326402. doi:10.33448/rsd-v11i3.26402.

[4] Mazer VBS, Moreira RS, Lima KC, Coriolano MGWS, Silva VL. Prevalência da participação de pessoas idosas brasileiras em Atividades Avançadas da Vida Diária e fatores associados. Rev Bras Epidemiol. 2024;27:e240070. doi:10.1590/1980-549720240070.2.

[5] Soares KG, Meneghel SN. O silêncio da sexualidade em idosos dependentes. Cien Saude Colet. 2021;26(1):129–136. doi:10.1590/1413-81232020261.30772020.

[6] Aguiar RB, Leal MCC, Marques APO, Torres KMS, Tavares MTDB. Idosos vivendo com HIV – comportamento e conhecimento sobre sexualidade: revisão integrativa. Cien Saude Colet. 2020;25(2):575–584. doi:10.1590/1413-81232020252.12052018.

[7] Alencar IT, Almeida DO, Couto ACO, Fontes JLF. Principais alterações imunológicas decorrentes da infecção pelo vírus da Imunodeficiência Humana Adquirida – HIV. Braz J Dev. 2022;8(7):50231–50252. doi:10.34117/bjdv8n7-101.

[8] Lucas MCV, Böschemeier AGE, Souza ECF. Sobre o presente e o futuro da epidemia HIV/Aids: a prevenção combinada em questão. Physis. 2023;33:e33053. doi:10.1590/S0103-7331202333053.

[9] Almeida AIS, Ribeiro JM, Bastos FI. Análise da política nacional de DST/Aids sob a perspectiva do modelo de coalizões de defesa. Cien Saude Colet. 2022;27(3):837–848. doi:10.1590/1413-81232022273.45862020.

[10] Ministry of Health. Secretariat of Health and Environmental Surveillance. Department of HIV, AIDS, Tuberculosis, Viral Hepatitis, and Sexually Transmitted Infections. Boletim Epidemiológico: HIV e Aids – Número Especial [Epidemiological Bulletin: HIV and AIDS – Special Issue]. Brasília: Ministry of Health; 2024.

[11] Monfardini AC, Sardo T, Bossardi CN, Souza CD, Ploner KS. Sexualidade na terceira idade: conhecimento e atitude de idosos de uma cidade litorânea do sul do país. RBCEH. 2022;19(1):51–59. doi:10.5335/rbceh.v19i1.8302.

[12] Lima IC, Fernandes SL, Miranda GR, Guerra H, Loreto RO. Sexualidade na terceira idade e educação em saúde: um relato de experiência. Rev Saude Publica Parana. 2020;3(1). doi:10.32811/25954482-2020v3n1p137.

[13] Domingues CL, Pereira TTJ, Ramos ASMB, Souza SBJ, Carvalho LKCAA, Silva DLS, et al. Perfil epidemiológico dos portadores de HIV/AIDS na capital do estado do Maranhão no período de 2014 a 2017. Braz J Dev. 2022;8(4):23212–23223. doi:10.34117/bjdv8n4-032.

[14] Lima ID, Sousa FLR, Oliveira AJSC, Silva ALS. Perfil epidemiológico dos casos de HIV/AIDS de 2001 a 2021 em uma cidade no Maranhão. Rev CCS. 2021;35(2). doi:10.51723/hthfht02.

[15] Brazilian Ministry of Health. DATASUS. TABNET. Brasília (DF): Ministry of Health; 2022. Available from: https://www2.aids.gov.br/cgi/deftohtm.exe?tabnet/br.def. Accessed February 4, 2024.

[16] Brazil. Ministry of Health. Ordinance No. 1,271, June 6, 2014. Available from: http://bvsms.saude.gov.br/bvs/saudelegis/gm/2014/prt1271_06_06_2014.html. Accessed June 20, 2024.

[17] Batista JFC, Oliveira MR, Pereira DLM, Matos MLSS, Souza IT, Menezes MO. Distribuição espacial e tendência temporal da AIDS no Brasil e regiões entre 2005 e 2020. Rev Bras Epidemiol. 2023;26:e230002. doi:10.1590/1980-549720230002.2.

[18] Vergara AG, Ferreira KCB, Silva WMM, Bordignon ACG, Silva JB, Freitas ALG, et al. HIV em idosos: uma abordagem geral. Rev Contemp. 2023;3(12):30789–30800. doi:10.56083/RCV3N12-303.

[19] Silva EM, Santos BS, Santos GVS, Freire ARJ, Valentim AR, Gomes ALF, et al. Epidemiological profile of AIDS in the elderly in the municipality of Aracaju, Sergipe. Res Soc Dev. 2022;11(10):e286111032810. doi:10.33448/rsd-v11i10.32810.

[20] Vieira CPB, Costa ACSS, Dias MCL, Araújo TME, Galiza FT. Tendência de infecções por HIV/Aids: aspectos da ocorrência em idosos entre 2008 e 2018. Esc Anna Nery. 2021;25(2):e20200051. doi:10.1590/2177-9465-EAN-2020-0051.

[21] Nicaretta RJ, Ferretti F, Portella MR, Ferraz L. Itinerário terapêutico de idosos vivendo com HIV/Aids: perspectivas da história oral. Physis. 2023;33:e33013. doi:10.1590/S0103-7331202333013.

[22] Crema IL, De Tilio R. Sexualidade no envelhecimento: relatos de idosos. Fractal Rev Psicol. 2021;33(3):182–191. doi:10.22409/1984-0292/v33i3/5811.

[23] Knauth DR, Hentges B, Macedo JL, Pilecco FB, Teixeira LB, Leal AF. O diagnóstico do HIV/aids em homens heterossexuais: a surpresa permanece mesmo após mais de 30 anos de epidemia. Cad Saude Publica.

2020;36(6):e00170118. doi:10.1590/0102-311X00170118.

[24] Lemos ACS. Ocorrência de HIV na população idosa do Brasil. REASE. 2023;1(1):468–477. doi:10.51891/rease.v1i1.10538.

[25] Castro APR, Moreira MRC, Morais APP, Neves FR, Pinheiro IM, Pinto AGA, et al. Incidentes críticos na convivência familiar e social de idosos com HIV/AIDS. Arq Cienc Saude Unipar. 2023;27(6):2863–2882. doi:10.25110/arqsaude.v27i6.2023-046.

[26] Martinho JS, Sena LWP, Moreira MP, Ikuta YM. Incidência de HIV/AIDS em pacientes idosos no estado do Pará, Brasil. Rev Eletron Acervo Saude. 2021;13(4):e6805. doi:10.25248/reas.e6805.2021.

[27] Souza IB, Tenório HAA, Gomes Junior EL, Marques ES, Cruz RAF, Silva RGM. Sociodemographic profile of elderly persons with the human immunodeficiency virus in a state in the northeast of Brazil. Rev Bras Geriatr Gerontol. 2019;22(4):e190016. doi:10.1590/1981-22562019022.190016.

[28] Brazilian Ministry of Health. Epidemiological Bulletin: Black Population Health. 2nd ed. Brasília (DF): Ministry of Health; 2023. 57 p. Available from: https://www.gov.br/saude/pt-br/centrais-de-conteudo/publicacoes/boletins/epidemiologicos/especiais/2023/boletim-epidemiologico-saude-da-populacao-negra-numero-especial-vol-2-out.2023/view. Accessed June 23, 2025.

[29] Santos TC, Andrade ACS, Viana IG, Silva RMA, Bezerra VM. Análise temporal da incidência de HIV/AIDS em idosos no período de 2007 a 2020. Rev Bras Geriatr Gerontol. 2021;24(5):e220005. doi:10.1590/1981-22562021024.220005.pt.

[30] Arruda de Carvalho P, Picone Borges de Aragão I. Epidemia de HIV/AIDS entre a população idosa do Brasil de 2008 a 2018: uma análise epidemiológica. HU Rev. 2022;48:1–7. doi:10.34019/1982-8047.2022.v48.37626.

[31] Vicente JDS, Dantas CF, Silva LSR, Lima KRM, Santana JRM, Trajano LM, et al. Delineamento epidemiológico dos casos notificados de 2008 a 2018 de HIV em pessoas idosas no estado de Pernambuco, Brasil. Rev Eletron Acervo Saude. 2021;13(5):e7365. doi:10.25248/reas.e7365.2021.

[32] Carmo RA, Policena GM, Alencar GP, França EB, Bierrenbach AL. Subnotificação de óbitos por AIDS no Brasil: linkage dos registros hospitalares com dados de declaração de óbito. Cien Saude Colet. 2021;26(4):1299–1310. doi:10.1590/1413-81232021264.15922019.