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Invisible Epidemic: The Role of Silent HIV Transmitters

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Abstract

Despite significant global progress in HIV prevention and treatment, a substantial proportion of new infections continues to originate from individuals who are unaware of their seropositive status. These "silent transmitters" asymptomatic carriers who remain undiagnosed represent a critical and often overlooked driver of ongoing HIV transmission. This article explores the epidemiological, biological, and social dimensions of silent transmission and highlights its public health implications. Through an interdisciplinary lens, we examine the demographic and behavioral profiles of silent transmitters, the obstacles they face in accessing testing, and the consequences of delayed diagnosis on both individual and community health

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outcomes. We also assess the limitations of current screening strategies and propose targeted screening interventions, including self-testing, community-based outreach, and digital health tools. Addressing the invisible spread of HIV requires a paradigm shift in public health programming one that prioritizes early detection, reduces stigma, and integrates inclusive, community-centered approaches. By focusing on silent transmitters, stakeholders can close critical gaps in the care continuum and accelerate progress toward epidemic control.

Keywords: Silent HIV transmitters; Targeted HIV testing; sociocultural barriers to testing; Innovative HIV screening strategies.

Introduction

Despite advances in treatment and prevention, HIV remains a major public health challenge globally and particularly in sub-Saharan Africa. One overlooked contributor to the persistence of the epidemic is the group of silent transmitter's individuals unaware of their HIV-positive status who, though asymptomatic, contribute significantly to virus transmission. These "silent transmitters" represent a critical blind spot in current strategies. Their undiagnosed status allows them to transmit the virus unknowingly, complicating detection and prevention efforts and posing a significant threat to public health. This phenomenon creates what can be described as an "invisible epidemic" within the broader HIV/AIDS crisis, where undiagnosed cases perpetuate transmission chains silently and steadily. Previous studies have emphasized the substantial role of acute and asymptomatic infections in sustaining HIV spread, yet these findings have often been treated as secondary to more visible modes of transmission [1, 2]. However, our analysis contends that silent transmission is not merely an epidemiological oversight, but a structural consequence of social inequalities, health system gaps, and persistent stigma surrounding HIV testing.

From a theoretical standpoint, the notion of "silent transmitters" can be understood as a socially produced invisibility, shaped by fear of discrimination, gender norms, and the limited integration of routine HIV testing in primary healthcare. This perspective moves beyond the biological interpretation of silent infection to emphasize the systemic silence where social, cultural, and institutional factors collectively hinder early detection. After reviewing the literature, we suggest that the "silent transmitter" phenomenon results from three main factors: late diagnosis caused by limited access to testing, misunderstanding of personal risk, and the quiet normalization of HIV in communities where symptoms are often ignored or mistaken. Using this perspective, our article not only describes who silent transmitters are, but also questions why the health system fails to detect them. The goal of this paper is to examine the role of silent transmitters in the spread of HIV, understand their demographic and behavioral characteristics, identify barriers to diagnosis, and suggest targeted screening strategies that address both the biological and social sides of silence in the HIV epidemic.

Characteristics of Silent Transmitters

Silent transmitters of HIV represent a significant yet underexplored challenge in the global fight against the epidemic. They unknowingly contribute to the continued spread of the virus due to their undiagnosed status and often asymptomatic presentation. Silent transmitters are individuals infected with HIV who remain undiagnosed and asymptomatic for prolonged periods. They are unaware of their HIV-positive status and therefore do not take precautions to prevent transmission to others. This silent phase, also known as the clinical latency phase, may last for several years, during which the individual feels healthy and appears outwardly normal. Unlike the acute or AIDS stages, no physical signs or symptoms are present, making it difficult for these individuals to suspect infection or seek testing.

However, while classical studies have described the clinical latency period as a virological plateau, our interpretation suggests that this apparent stability masks a dynamic and socially sustained silence [3, 4]. In contexts such as sub-Saharan Africa, this phase coincides with social invisibility where lack of systematic screening, gender dynamics,

and stigma reinforce the biological latency of the virus. The silent transmitter, therefore, is not only a biological entity but also a social construct resulting from weak health systems and cultural reticence around testing.

The HIV virus, a retrovirus that integrates its genetic material into host cells primarily CD4+ T lymphocytes gradually undermines immune function [5, 6]. During the clinical latency phase, viral replication persists at low levels, and although viral load stabilizes, transmissibility remains significant [7]. Yet, most latency characterizations performed in the laboratory remain disconnected from the realities in the field. For instance, while studies highlight the role of viral tropism (R5 or X4) [8, 9]. In transmissibility, few explore how these biological variants interact with behavioral or sociocultural contexts, such as multiple concurrent partnerships or delayed healthcare seeking. This gap highlights the need for integrated bio-sociological studies that bridge molecular and behavioral epidemiology.

Fear of stigma, anxiety about diagnosis, and misinformation continue to discourage testing [10, 11]. Myths and cultural beliefs about HIV and sexuality exacerbate denial and delay diagnosis, particularly among young adults and women, who often face double vulnerability: social judgment and economic dependence. The lack of comprehensive sexual education further limits awareness of risk and the perceived need for [12, 13].

From our point of view the idea of silent transmitters can be explained by what we call the "triangle of silence" a model that links three interdependent factors: biological silence when the virus is hidden but can still spread; social silence when people deny, fear stigmazed, or share misinformation and institutional silence when there is a lack of active testing and follow-up. These three parts make HIV transmission less visible in the community. To create better and more sensitive solutions it's important to understand and deal with each part. Instead of seeing silent transmitters as just carriers this view shows them as signs of larger system problems in communication, education, and healthcare access.

Differences with Symptomatic Individuals

Silent Transmitters Differ From Symptomatic Individuals in Several Key Ways

Behavioral Awareness

Symptomatic individuals are more likely to suspect infection and seek medical care, whereas silent transmitters often perceive themselves as healthy and do not recognize the need for testing [14]. In a study conducted in Rakai District, Uganda, it was found that individuals who reported no HIV-related symptoms were 70% less likely to present for voluntary counseling and testing compared to those who had perceived symptoms. This gap highlighted how asymptomatic individuals underestimated their risk, resulting in lower testing uptake [15]. A national survey revealed that many people did not seek testing because they felt "in good health," even in high-prevalence areas. This perception led to delayed diagnosis, especially among men and youth [16, 17].

Health-Seeking Behavior

Those with symptoms engage more frequently with health systems; silent transmitters may avoid healthcare due to absence of symptoms or fear of stigma. In KwaZulu-Natal, a study showed that people living with HIV who experienced stigma in health facilities were significantly less likely to return for follow-up, especially if they were not experiencing symptoms. This reduced continuity of care and delayed ART initiation for asymptomatic individuals [18]. A study among urban youth found that asymptomatic individuals delayed testing because they avoided health centers for fear of being seen and judged, despite knowing the risks. This avoidance contributed to late diagnosis and poorer outcomes [19].

Infectiousness Period

Silent transmitters may unknowingly transmit HIV over a longer period, especially during acute infection when viral load peaks despite lack of symptoms [20]. In Tanzania, a cohort study demonstrated that early infections accounted for over 30% of new transmissions in discordant couples. Most transmitters in this group were asymptomatic and unaware of their status, showing how acute silent infections drive transmission [21]. A study on transmission dynamics in high-incidence districts revealed that the greatest risk of onward transmission came from individuals recently

infected, most of whom did not present symptoms and had not tested yet. This finding informed the rollout of community-based early testing campaigns [22].

Clinical Detection

Symptomatic individuals are often diagnosed during consultations for opportunistic infections, while silent transmitters require routine or targeted screening for identification.

Hospital records from Addis Ababa showed that over 60% of HIV diagnoses occurred after a symptomatic presentation, often late-stage, while targeted community testing initiatives identified asymptomatic carriers earlier, allowing for timely ART [23]. A random sampling study in a peri-urban South African community found a high HIV prevalence (22.7%) and a significant burden of previously undiagnosed HIV (10.3%), especially among those who had recently tested negative, underscoring the critical need for frequent repeat testing and innovative prevention strategies [23]. Another study comparing self-initiated HIV counselling and testing (HCT) found that mobile services were significantly more effective than clinics at reaching males and older adults, often through opportunistic visits, confirming the value of mobile HCT as a complementary strategy to reach populations that typically do not access clinic-based services [24].

Consequences for Health and Epidemic Control

Delayed diagnosis in silent transmitters increases the risk of disease progression to AIDS and associated comorbidities [25]. Epidemiologically, silent transmitters sustain transmission chains, making epidemic control more difficult [26]. Ethical issues arise concerning confidentiality, consent, and responsibility for transmission, necessitating sensitive approaches in testing and disclosure.

Demographic and Behavioral Profile

Silent transmitters are not a homogenous group; their characteristics vary by age, gender, social context, and vulnerability. However, clear demographic and behavioral trends emerge across regions particularly in Africa where sociostructural determinants and inequalities shape testing behavior and HIV risk.

Youth and Adolescents

Youth often lack access to comprehensive sexual education and face legal or parental consent barriers to HIV testing. This contributes to underestimation of personal risk and lower testing uptake [26]. In South Africa, a study of adolescents in Gauteng Province, less than 30% had ever been tested for HIV, with fear of disclosure, low perceived risk, and lack of youth-friendly services identified as main barriers. The program response included school-based testing campaigns, which improved testing rates by 20% [27]. In Kenya, the "Y-ACT" project involved peer-led community outreach and mobile testing among adolescents, leading to a notable increase in voluntary testing, particularly among girls. However, retention in care remained low, pointing to the need for youth-centered follow-up mechanisms [28].

Women

In many sub-Saharan countries, gender inequality and limited decision-making autonomy in health matters increase women's vulnerability to silent HIV transmission [29]. In Malawi, a PMTCT (Prevention of Mother-To-Child Transmission) program found that women not enrolled in antenatal care had significantly lower testing rates and higher rates of late HIV diagnosis. A community-based survey in Western Kenya found that while antenatal HIV testing uptake was high (87%), ARV coverage for PMTCT was incomplete (54% completing the full course) and often undisclosed to the survey team, highlighting the need for strategies promoting early ANC, partner involvement, and skilled delivery to further reduce vertical transmission [30]. A cameronian study revealed that fear of partner violence prevented many women from disclosing their status or accessing testing. Integration of gender-based violence (GBV) counseling into maternal health services improved uptake and reduced post-test abandonment [31].

Key Populations (MSM, Sex Workers, PWID, Transgender Individuals)

These groups are overrepresented in new infections but severely underserved by health systems due to stigma, discrimination, and criminalization [32]. In Senegal, a peer-led initiative among men who have sex with men pro-

vided community testing, ART linkage, and legal support. It successfully doubled the HIV testing rate in this population within two years, proving that trusted community channels improve outreach [33]. In Nigeria, among sex workers in Lagos, fear of police harassment and clinic discrimination deterred facility visits. Mobile clinics offering anonymous testing and PrEP increased testing by 40% over six months [34].

Older Adults

Although often left out of HIV prevention programs, older adults continue to engage in sexual activity, often without protection, and rarely perceive themselves at risk [35]. In Uganda, a 2021 study showed that individuals aged 50+ had lower testing rates, even though HIV prevalence was rising in this age group. Tailored community sensitization increased voluntary testing by 25% in targeted districts [36]. A qualitative study in Victoria, Australia, found that while GPs and practice nurses believed discussing sexual health with older patients was appropriate, most did not routinely initiate these conversations, citing barriers like age/gender discordance and complex comorbidities, which suggests an unmet need for provider-initiated sexual health discussions in general practice [37].

Migrants and Mobile Populations

Migrants often experience disrupted health services, fear of legal consequences, and language barriers, all of which limit access to testing and continuity of care [38]. In Côte d'Ivoire and Burkina Faso, a cross-border HIV initiative targeting truck drivers and seasonal laborers showed that mobile testing centers along major transit routes increased test coverage by over 50% in just one year [39]. In South Africa, the Médecins Sans Frontières (MSF) program in Musina offered testing and ART to undocumented migrants and refugees, reducing new infection clusters in the area by focusing on mobile, culturally adapted, no-ID testing services [40]. These groups often engage in risk behaviors such as unprotected sex or multiple partnerships, amplifying silent transmission in communities.

Psychosocial and Psychological Dimensions

Beyond structural barriers, psychological factors play a critical role. Fear of stigma and discrimination leads to denial and avoidance of testing. Anxiety about a positive diagnosis can cause individuals to delay or refuse testing despite risk exposure [41]. Cultural myths and misinformation about HIV transmission and treatment further discourage testing and disclosure. Comprehensive sexual education and community sensitization are vital to counteract these psychosocial barriers.

Biological and Immunological Mechanisms

The virus's ability to remain latent within host cells during the asymptomatic phase is linked to complex immunological interactions. HIV targets CD4+ T cells, macrophages, and dendritic cells, progressively impairing immune function [5]. The virus's high mutation rate during reverse transcription allows it to evade immune responses and develop drug resistance [6]. Understanding these mechanisms is crucial for developing early detection tools and therapeutic strategies.

Legal, Political, and Institutional Barriers

Legal frameworks criminalizing key populations or certain behaviors deter individuals from seeking testing and care. Confidentiality concerns and fear of legal repercussions inhibit engagement with health services. Additionally, insufficient political commitment and funding limit the expansion of testing infrastructure and outreach programs, particularly in resource-limited settings [26]. Addressing these systemic issues is essential to improve detection of silent transmitters.

Technological Innovations for Detection

Emerging technologies such as rapid diagnostic tests, self-testing kits, and molecular assays enable earlier and more accessible detection of HIV infection [29]. Digital tools including mobile apps for appointment booking, tele--counseling, and SMS reminders improve linkage to care and adherence. Biomarkers and next-generation sequencing hold promise for identifying infection during very early stages, potentially reducing the silent transmission window.

Epidemiological Impact of Silent Transmitters

Silent transmitter's individuals living with HIV who are unaware of their status play a central role in the

continuation of transmission chains. These individuals, by remaining undiagnosed and untreated, often maintain high viral loads, particularly during the acute infection phase, making them more infectious than those on treatment with viral suppression [20]. Unlike individuals who are aware of their HIV-positive status and receive antiretroviral therapy (ART), silent transmitters continue to unknowingly spread the virus through unprotected sex, needle sharing, and other high-risk behaviors. According to Cohen et al. (2011), individuals who are unaware of their HIV status are more than twice as likely to transmit the virus compared to those who know their status and are on treatment [3] Their presence undermines progress toward epidemic control: even with increased ART coverage and prevention programs, the persistence of this undiagnosed reservoir creates a hidden but potent vector of infection, particularly in populations with low testing coverage.

According to UNAIDS (2023), an estimated 9.2 million people globally were living with HIV in 2022 without knowing their status, representing approximately 12% of all people living with HIV [26]. This group of undiagnosed individuals is responsible for an estimated 40–50% of new infections worldwide. In sub-Saharan Africa, where the epidemic is most severe, UNAIDS data indicate that up to 60% of new infections in some countries may be linked to people who are unaware of their status, underscoring the epidemiological weight of silent transmission.

Implications for Public Health Programs

Implications for public health programs include the need to address the challenge posed by silent transmitters, who undermine the effectiveness of HIV testing and treatment as prevention strategies. Programs that focus mainly on individuals already diagnosed or those seeking care overlook a substantial portion of the transmission network. To counter this, public health initiatives must expand routine and community-based testing, particularly targeting high-risk and hard-to-reach populations, integrate index testing and self-testing options, utilize geospatial tools and behavioral data to identify and intervene in areas with likely undiagnosed infections, and ensure robust linkages to care for newly diagnosed individuals. Failure to identify and engage silent transmitters sustains ongoing infection cycles, delays epidemic control, and escalates long-term healthcare costs [42].

Obstacles to Diagnosis

Despite advances in technology and awareness campaigns, diagnosing silent HIV transmitters remains a significant challenge. These obstacles are multifaceted, encompassing sociocultural, economic, and structural dimensions that hinder early detection and effective control of the epidemic. Stigma, taboos, and discrimination remain among the most formidable barriers to HIV diagnosis. In many communities, HIV is heavily stigmatized and often linked to behaviors considered immoral or socially unacceptable, such as drug use or non-heteronormative sexual practices [11, 26]. This stigma fosters fear of rejection by family, friends, and society, discouraging individuals from seeking testing or disclosing their status [43].

Moreover, cultural taboos surrounding sexuality further restrict open discussions about HIV prevention and testing, particularly affecting women and young people who may lack access to accurate information or feel unable to negotiate testing within their social contexts [44]. This culture of silence exacerbates misinformation and perpetuates the cycle of undiagnosed infections. Discrimination within healthcare settings also undermines trust and deters individuals from accessing testing services [45]. Addressing these sociocultural barriers requires community engagement, education, and sensitization to reduce stigma and normalize HIV testing as a routine health practice.

Geographical and financial barriers significantly limit access to HIV testing, especially in rural and remote regions [46]. Health facilities may be sparse or located far from vulnerable populations, making physical access difficult. Additionally, indirect costs such as transportation fees, lost wages, and time away from work create further disincentives for individuals to seek testing [47]. In many low- and middle-income countries, healthcare infrastructure is often inadequate, with shortages of trained personnel and limited availability of rapid diagnostic tests [26]. This scarcity leads to long waiting times, inconsistent testing quality, and sometimes stockouts of essential supplies, all of which compromise timely diagnosis.

Strengthening healthcare systems through investment in infrastructure, training, and decentralized testing services, including community-based and self-testing options, can improve accessibility and uptake [48]. The prolonged asymptomatic phase of HIV infection poses a unique challenge for early diagnosis. Many individuals infected with HIV remain symptom-free for several years, leading to a false sense of security and a low perceived need for testing [49]. This misperception is compounded by insufficient education on HIV transmission and progression, resulting in underestimation of personal risk [41]. Without visible symptoms, individuals may not recognize the importance of regular testing, particularly if they do not belong to traditionally high-risk groups or if they believe their behaviors are safe [50]. Enhancing awareness through targeted education campaigns that emphasize the silent nature of HIV infection and the benefits of early diagnosis is essential to motivate testing uptake.

In several countries, the lack of coherent and enforced national policies for HIV testing significantly hinders widespread and routine screening. Policy shifts and health priorities focusing on other pressing issues can divert resources away from HIV programs [26]. Weak governance, insufficient funding, and poor monitoring mechanisms contribute to a fragmented response, especially in resource-limited settings [51]. Strengthening political commitment and integrating HIV screening into broader universal health coverage frameworks is crucial.

Gender-based barriers persist, particularly for women who face violence, economic dependency, and low health decision-making autonomy, which inhibit access to testing services [26]. On the other hand, men often avoid healthcare services due to gender norms that discourage help-seeking behavior, leading to underdiagnosis in male populations [52]. These inequalities require gender-sensitive interventions, targeted outreach, and structural empowerment strategies. Populations most at risk such as sex workers, men who have sex with men, people who inject drugs, and incarcerated individuals face compounded legal, social, and systemic barriers. Criminalization, fear of police repression, and social exclusion deter these groups from accessing voluntary testing services [32, 53]. Decriminalization and inclusive public health strategies are essential for reaching these populations.

Concerns about confidentiality and the risk of involuntary disclosure of HIV status discourage many individuals from seeking testing, especially in tight-knit or rural communities [18]. Weak data protection systems and untrained health personnel further aggravate these fears. Strengthening patient confidentiality protocols and offering anonymous or self-testing options can help build trust. Even when people get tested, the absence of post-test counseling, psychosocial support, and referral systems disrupts the continuum of care. This is particularly critical for newly diagnosed individuals, who may abandon follow-up if they feel unsupported [54]. Ensuring linkage to care and holistic support services is vital for the sustainability of testing programs.

Strategies for Targeted Screening

To overcome barriers to HIV testing and improve the identification of silent transmitters, it is essential to implement innovative, context-adapted strategies. These approaches should leverage community engagement, technology, and integration into existing health services to maximize reach and effectiveness.

Community-based testing strategies utilize mobile units, local leaders, and trusted community structures to bring HIV testing closer to populations who face geographic or social barriers to healthcare access. Mobile testing campaigns organized in markets, schools, places of worship, and community centers have proven effective in reaching rural and underserved urban populations, reducing disparities in testing coverage [55].

Engaging community leaders and peer educators helps to build trust, reduce stigma, and encourage participation. This approach fosters a supportive environment where individuals feel more comfortable accessing testing services outside traditional clinical settings [56].

Index testing involves offering HIV testing to the sexual partners, family members, and close contacts of individuals diagnosed with HIV. This targeted strategy increases the likelihood of identifying undiagnosed cases within social networks where transmission risk is higher [57].

When implemented with confidentiality and consent safeguards, index testing is a cost-effective method to reach hidden populations and interrupt transmission chains. Training healthcare workers to conduct sensitive and ethical index testing is critical for its success. HIV self-testing (HIVST) empowers individuals to perform the test privately using kits available at pharmacies or distributed by NGOs. This method addresses stigma and confidentiality concerns that often deter people from seeking facility-based testing [58]. Self-testing has shown promising results, especially among young people and key populations who may fear discrimination. It offers convenience and autonomy, enabling individuals to learn their status in a safe environment. The World Health Organization recommends HIVST as a complementary approach to conventional testing services [29].

The integration of digital technologies enhances access and follow-up in HIV testing programs. Online platforms allow individuals to book testing appointments discreetly, reducing barriers related to stigma or scheduling conflicts. Tele-counseling services provide pre- and post-test support remotely, improving linkage to care. SMS reminders and follow-up messages help ensure that individuals receive their results and engage in care promptly [59]. These digital innovations are particularly valuable for reaching younger demographics and urban populations with high mobile phone penetration.

Certain populations, including women, men who have sex with men (MSM), sex workers, and people who inject drugs, face disproportionate HIV risk and unique barriers to testing. Integrating HIV screening into reproductive health services, such as antenatal care, family planning, and sexual health clinics, ensures early diagnosis and prevention of mother-to-child transmission [57]. Tailored services developed in partnership with community-based organizations can address the specific needs of key populations, providing culturally sensitive, stigma-free environments. Outreach programs and peer-led initiatives are effective in increasing testing uptake among these groups [56].

Routine integration of HIV testing into clinical visits for tuberculosis (TB), sexually transmitted infections (STIs), and prenatal care enhances early detection of HIV cases that might otherwise go unnoticed [13]. Since co-infections are common, this approach capitalizes on existing healthcare encounters to offer testing opportunistically [56]. Such integration not only improves diagnosis rates but also facilitates comprehensive care management, linking patients to antiretroviral therapy and support services promptly. Pharmacies and private healthcare providers often serve as the first point of contact for people with health concerns, especially in underserved or stigmatized populations. Involving private actors in HIV testing, through training and the supply of self-test kits, has proven effective in expanding coverage beyond public health infrastructure [60]. This strategy also responds to confidentiality concerns and the need for convenience.

Introducing HIV education and voluntary testing in schools and workplaces increases access among young people and working adults. Workplace programs offering on-site, confidential testing encourage uptake by reducing the time and cost barriers associated with accessing health services externally [61]. School-based approaches are particularly effective for reaching adolescents before they become sexually active. Spatial analysis using GIS can help identify HIV hotspots and underserved regions, allowing targeted deployment of testing services where the need is greatest [62]. This data-driven approach increases efficiency, reduces costs, and ensures high-impact interventions in concentrated epidemic zones. Peer navigation programs, where individuals living with HIV support others through the testing and linkage-to-care process, increase trust and reduce dropouts from the care continuum. These peers provide psychosocial support, accompany individuals to appointments, and offer real-life testimonials that motivate others [63].

Discussion

The persistence of HIV transmission through silent transmitters reveals critical weaknesses in current public health approaches, particularly when strategies are not adequately aligned with the observed barriers to diagnosis and care. Despite technological advances and expanded testing programs, a significant proportion of people living with HIV remain undiagnosed, perpetuating the epidemic and undermining global control efforts.

Cross-Referencing Strategies and Barriers

While strategies such as community-based testing, self-testing, and index testing have demonstrated success in expanding HIV detection, their reach remains limited by sociocultural, structural, and systemic barriers previously identified.

Community-based and mobile testing units have been shown to increase testing uptake in underserved areas. For example, a study in rural South Africa demonstrated that mobile testing campaigns significantly improved HIV status awareness among hard-to-reach populations [56]. However, these programs often face logistical challenges such as limited funding, transportation difficulties, and shortages of trained personnel, especially in conflict-affected or remote regions [29]. This limits their sustainability and scalability.

Index testing, which targets sexual and needle-sharing partners of diagnosed individuals, is highly efficient in identifying new cases [57]. Yet, ethical concerns arise regarding confidentiality and potential social harms, including stigma, discrimination, or even intimate partner violence. For instance, a qualitative study in Kenya highlighted that some individuals feared disclosure during partner notification, resulting in underutilization of index testing services [64].

Self-testing offers privacy and convenience, effectively overcoming barriers related to stigma and confidentiality. A randomized trial in Malawi showed that HIV self--testing doubled the uptake of testing among men, a group traditionally less likely to test [65]. Nevertheless, limited availability, cost, and lack of linkage to care remain obstacles, particularly for marginalized populations such as sex workers and people who inject drugs [66].

Evaluating the Effectiveness of Current Approaches

Despite international efforts, global data indicate that approximately 12% of people living with HIV remain undiagnosed [26]. This gap is more pronounced in key populations men who have sex with men (MSM), transgender individuals, sex workers, and migrants who face heightened stigma, criminalization, and social exclusion [32].

Moreover, gender-based violence and migration status critically influence access to testing. For example, a systematic review by [54] found that women experiencing intimate partner violence were less likely to access HIV testing services due to fear and control by partners [54]. Similarly, migrants often encounter legal and language barriers that hinder engagement with healthcare systems [38]. Another major limitation is the weakness in linkage to care and retention post-diagnosis. Studies in sub-Saharan Africa reveal that up to 40% of individuals diagnosed with HIV fail to initiate antiretroviral therapy promptly, undermining the benefits of early detection [54]. This gap is exacerbated by distrust in health systems, poor counseling, and socioeconomic constraints.

Emphasizing Innovation and Social Inclusion

To effectively reach silent transmitters and move toward epidemic control, HIV testing and diagnosis strategies must be reimagined through the lenses of equity, inclusion, and innovation. Technological innovations such as digital contact tracing, geospatial mapping, and artificial intelligence (AI)-driven risk prediction models have shown promise in improving case finding and resource allocation.

Social innovations, including community-led testing, peer navigation, and inclusive policy reforms, can dismantle barriers related to stigma and criminalization. [67] Demonstrated that community-based peer support significantly reduced internalized stigma and improved engagement in care among people living with HIV [67]. There is a pressing need for gender-responsive and culturally tailored programs. Adolescents, migrants, LGBTQ+ individuals, and older adults require interventions sensitive to their unique social and cultural contexts. For instance, youth-friendly services in Kenya incorporating mobile health platforms increased testing uptake by 30% among adolescents [60].

Finally, integrating HIV testing into broader primary healthcare and universal health coverage frameworks can normalize testing, reduce stigma, and improve sustainability. Countries like Rwanda have successfully embedded HIV testing within routine health services, achieving high testing coverage and linkage to care [68].

Recommendations

To effectively reduce the impact of silent HIV transmission, public health systems must adopt a comprehensive, inclusive approach based on the reality of undiagnosed populations. It is essential to strengthen awareness campaigns to develop and disseminate culturally and age-appropriate educational messages for different target groups, highlighting the reality of asymptomatic infections and the importance of early testing. These messages must correct misconceptions, promote knowing one's serological status as an act of responsibility and empowerment, and be relayed by trusted local figures, digital media, educational institutions, and professional settings. The goal is to normalize HIV testing as a routine part of healthcare, just like other medical examinations.

The systematic integration of HIV testing into general health services also represents a priority. Testing should be routinely offered during medical consultations, STI screenings, prenatal care, and tuberculosis control services. This non-discriminatory approach, based on the principle of presumed consent, allows for the identification of silent virus carriers during medical visits for other reasons. It must be accompanied by training for health personnel focused on empathy, confidentiality, and reducing stigma to encourage patient acceptance of the test.

Particular attention must be paid to youth and vulnerable populations. Adolescents, young adults, as well as key groups such as men who have sex with men, sex workers, migrants, and drug users, require targeted interventions to overcome the social and legal barriers that limit their access to health services. Women and young girls must be reached through the integration of testing into reproductive and maternal health services. These actions can include mobile campaigns, peer education programs, distribution of self-tests, and the creation of safe spaces for counseling and testing.

Finally, community mobilization and the fight against stigma are essential levers for lasting change. Local interventions must foster dialogue, highlight the testimonies of people living with HIV, and encourage the active participation of religious leaders, youth groups, and community influencers. The involvement of people living with HIV in peer navigation programs builds trust, supports adherence to treatment, and promotes better social acceptance. In short, public health responses must be inclusive, based on solidarity and the strengthening of community capacities, in order to transform the fight against HIV into a collective, human, and sustainable effort.

Conclusion

Silent transmitters represent an invisible yet potent force sustaining the HIV epidemic, particularly in high-prevalence regions where testing remains limited or stigmatized. Their ability to unknowingly transmit the virus while appearing healthy makes them a critical blind spot in traditional prevention and treatment programs. Identifying and reaching these individuals is essential not only to interrupt transmission chains but also to ensure that no one is left behind in the global HIV response.

However, the implementation of strategies to detect and manage silent transmitters faces multiple local challenges. In sub-Saharan African settings, limited laboratory infrastructure, irregular supply of diagnostic kits, and a lack qualified personnel hinder the operationalization of widespread screening. In rural and peri-urban communities, long distances to testing centers and fear of stigma discourage individuals from seeking voluntary testing. Moreover, social taboos around sexuality and gender inequalities often reduce women’s autonomy to access testing or disclose their status. These context-specific obstacles must be recognized when designing interventions to ensure their cultural acceptability and sustainability.

To combat silent transmission, it is necessary to strengthen the integration of medical and social strategies, broaden the use of technologies for targeted and decentralized screening, such as mobile screening units, HIV self-tests, and community digital alerts, as well as to renew political and community commitment to equity and inclusion. From a scientific standpoint, this paper contributes to reframing the silent transmitter phenomenon not only as a biomedical issue but as a multi-dimensional system failure a result of biological latency, social silence, and institutional inaction. This conceptual lens the triangle of silence offers a

new way to analyze how undiagnosed infections persist despite biomedical progress. For future studies, the authors recommend interdisciplinary research combining molecular monitoring, behavioral analysis, and health-system evaluation to better capture the interactions sustaining silent transmission. Longitudinal community-based studies should also explore how stigma reduction, self-testing uptake, and digital health tools could improve early detection and follow-up of undiagnosed individuals. Only through coordinated, locally adapted, and stigma-free approaches can public health systems successfully detect silent transmitters and move closer to the goals of epidemic control and ultimately, the end of HIV as a global health threat.

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