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Challenges of integrating HIV prevention and treatment in China's border mountain regions: a grounded theory study

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Abstract

Background HIV remains a critical global public health challenge, with 39 million people living with HIV as of 2022 and over 40.4 million lives lost to the epidemic. In China, the burden is similarly significant, with over 1.33 million HIV cases reported as of 2024. The challenges are particularly acute in western regions like Yunnan Province, which face resource limitations, socio-demographic disparities, and a high prevalence of HIV among ethnic minorities.

Objectives This study examines the challenges in HIV diagnosis, treatment, and prevention across various institutions in Yunnan Province, including government bodies, hospitals, disease control centers, and primary healthcare institutions. This study aims to identify key challenges in integrating HIV prevention and treatment in China's border mountainous regions to inform targeted strategies for ethnic minority and impoverished communities.

Methods This study adopts a grounded theory approach to explore the systemic, socio-demographic, and cultural barriers impeding the integration of HIV prevention and treatment in M City, a resource-constrained border region in Yunnan Province. From May 2024 to January 2025, a comprehensive review of regional HIV prevention and control literature, alongside relevant World Health Organization (WHO) guidelines, was undertaken to contextualize the research. To capture multi-level insights, semi-structured interviews were conducted between August and December 2024 with 23 purposively selected participants, including individuals living with HIV, village doctors, healthcare providers, and local policymakers. The qualitative data were analyzed through a rigorous three-stage coding process—comprising open coding, axial coding, and selective coding—consistent with grounded theory methodology, to systematically construct and refine conceptual categories underpinning the integration challenges.

Results This study included 23 participants from Yunnan Province. Through three-level coding, three major themes were identified. In HIV prevention, key challenges included patients' inattention to prevention, difficulties for village doctors in home-based screening, and poor enthusiasm for prevention in hospitals. In HIV treatment, difficulties included limited government support, variability in patients' conditions, poor medication adherence, poor quality of village clinic services, challenges for healthcare staff, uncertain effects of Chinese and Western medicine synergy, and unsmooth referral mechanisms. In integration of HIV prevention and treatment, major issues involved low referral rates, loose inter-agency cooperation, and systemic barriers to integration.

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Conclusion This study highlights the complex challenges in HIV prevention, treatment, and integration in economically underdeveloped regions, emphasizing the need for improved patient awareness, healthcare system efficiency, and cross-institutional collaboration. Future research should focus on multi-center, longitudinal studies and real-world implementation to refine and scale the integration model for sustainable HIV care in these regions.

Keywords HIV prevention, HIV treatment, Integration of treatment and prevention, Grounded theory, Healthcare system, Comorbidities, Medication adherence, Resource-limited settings

Introduction

HIV remains a profound global public health challenge, claiming over 40.4 million lives to date, with an estimated 39 million people living with HIV by the end of 2022 [1]. Alarmingly, two-thirds of these cases (25.6 million) are concentrated in economically underdeveloped regions, particularly in sub-Saharan Africa. Despite ongoing advancements, the complexities of HIV prevention and control continue to hinder efforts worldwide. Key barriers include the limited accessibility and uptake of pre-exposure prophylactic (PrEP) drugs and the absence of an effective HIV vaccine [2, 3], the irreversible damage to the immune system caused by the virus [4], and its diverse transmission routes. These factors highlight the urgency of developing innovative approaches to prevention and treatment [5]. The reality of combating HIV now requires a collaborative synergy between patients, healthcare providers, community organizations, and government institutions to create effective social networks for intervention.

While progress has been made, such as a 57% reduction in new infections in Eastern and Southern Africa since 2010, the global picture remains deeply concerning [1]. Nearly 23% of all new HIV infections occur in Asia and the Pacific, with some countries experiencing alarming increases in infection rates. Eastern Europe and Central Asia have seen a 49% rise in infections since 2010 [6], while the Middle East and North Africa have experienced a 61% increase. These statistics underscore the persistent challenges facing less economically developed regions, including long incubation periods, stigma, low health literacy, and inadequate healthcare resources [7]. For instance, the availability and uptake of pre-exposure prophylaxis remain limited in resource-constrained areas, and self-testing remains inaccessible in many sub-Saharan African communities due to insufficient policy support and health education.

From a treatment perspective, the barriers are equally challenging. Patients in under-resourced regions face a stronger sense of stigma [8], reduced access to medication, and limited health literacy, resulting in poor adherence to antiretroviral therapy and a heightened risk of opportunistic infections [9–11]. Healthcare systems in these areas are often underfunded and overstretched, with limited capacity to manage increasing patient volumes. Weak policy frameworks and insufficient support from public health agencies further delay diagnosis and treatment, perpetuating a vicious cycle of transmission and poor health outcomes [10, 12].

HIV prevention and treatment in China face ongoing challenges, particularly in resource-limited areas and high-risk populations. According to data provided by the National Center for AIDS and Sexually Transmitted Disease Control and Prevention, Chinese Center for Disease Control and Prevention, as of December 31, 2024, a total of 1,355,017 cases of currently living HIV-infected individuals/AIDS patients were reported across 31 provinces (autonomous regions, municipalities directly under the central government) in China (excluding Hong Kong, Macau, and Taiwan), with 491,437 reported deaths. Among the living HIV-infected individuals, 749,839 cases were reported, while 605,178 cases were AIDS patients. [13].

The prevention, control, and treatment of AIDS in western China's economically underdeveloped regions face significant challenges due to rising infections and limited medical resources. In response, the Chinese government has adopted a"medicine and prevention integration model,"drawing from its experience in managing public health emergencies like COVID-19 [14, 15] XX. Introduced in 2018 through the"Contracted Services of Family Doctors,"this model focuses on integrating medical care and preventive services, emphasizing collaboration between patients, general practitioners, medical institutions, disease control centers, and government agencies. [15]In December 2023, the National Health Commission further refined this approach by strengthening county-level medical communities, particularly for vulnerable groups like those with chronic diseases, the elderly, and individuals with infectious diseases. [16]This model specifically addresses AIDS by integrating prevention, screening, diagnosis, treatment, and management, ensuring a coordinated approach that reduces transmission and prevalence through optimized service delivery. [17, 18].

The main reason for selecting the remote mountainous areas of China, where HIV prevention and control are most challenging, as the sample region for this study

includes: Firstly, Yunnan is the earliest region in China to experience the HIV epidemic. In October 1989, 146 cases of HIV infection were first reported among intravenous drug users in the border areas of Yunnan. Secondly, over the past decade, Yunnan has become a major hotspot for HIV transmission and prevalence in China, with the number of infections continuously rising at an exponential rate, maintaining the highest infection rate in the country for several years. Thirdly, the HIV prevention and control measures implemented in Yunnan serve as a model for other ethnic minority and impoverished regions worldwide [19]. Despite its high prevalence of behaviors such as men who have sex with men and intravenous drug use in a southwestern border region, Yunnan became the first province in China to achieve the goals of the"13 th Five-Year Plan"for HIV prevention and the"90–90-90"targets set by the United Nations AIDS Program, making it the only province to meet these targets by 2020 [20].

In M City, cumulative HIV cases reached 3,081 by 2022, with 906 deaths and 2,185 survivors. In 2023, 51 new cases were reported, driven by low condom use, limited health education, and inadequate interventions among vulnerable populations, including men who have sex with men and manual laborers. Cross-border migration from neighboring high-prevalence countries—Vietnam, Laos, and Myanmar—further exacerbates transmission. This study aims to delve into the systemic, social, and cultural challenges of implementing an integrated healthcare and prevention framework in resource-limited regions. Focusing on M City (Fig. 1), Yunnan Province—a border area in China with unique socio-demographic characteristics—the research identifies barriers faced by patients, village doctors, primary healthcare institutions, designated hospitals, CDC officials, and community workers. Through grounded theory, the study analyzes data collected from semi-structured interviews with 23 participants, with further details provided in Table 1 By systematically unpacking these challenges, this research seeks to contribute actionable insights for advancing HIV prevention and control strategies in under-resourced regions.

Methods

In 1960 s, Strauss and Corbin introduced"Grounded Theory Methodology,"which utilizes a three-level coding process for data analysis: Open Coding, Axial Coding, and Selective Coding [21]. The reasons for choosing this method are twofold. First, Grounded Theory (GT) allows for an in-depth exploration of the complex underlying causes behind the issue. The management and prevention of HIV involve numerous processes, such as the distribution of condoms and the provision of medications, and engage multiple stakeholders, including the government, hospitals, primary healthcare institutions, and disease control centers. This complexity makes it difficult to collect relevant data through quantitative methods such as surveys. Second, Yunnan lacks established theoretical models that address the intersection of economic, sociodemographic, and cultural factors influencing the HIV epidemic. GT's inductive framework is well-suited for theoretical development in this area, helping to uncover emerging models and processes of integrated HIV prevention and treatment. This can provide actionable

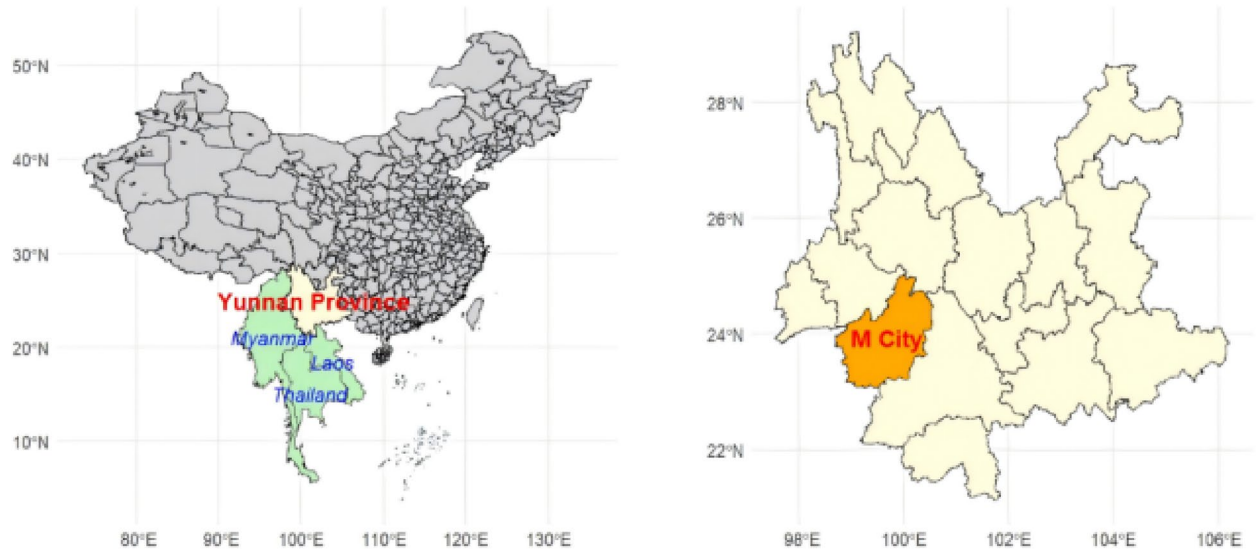

Fig. 1 Location map of M City(right), Yunnan Province(left)

Table 1 Demographics of participants (*n*= 23)

ID	Occupation	Education level	Years of work experience	Relationship status
A1	Person living with HIV	Junior high school	16	Single
A2	Person living with HIV	Junior high school	7	Single
B1	Village doctor	High school	20	Married
B2	Village doctor	High school	25	Married
C1	Chief nurse	Associate degree	21	Single
C2	Chief physician	Associate degree	27	Married
C3	Associate chief physician	Associate degree	24	Married
C4	Chief nurse	Bachelor's degree	15	Single
C5	Resident physician	Associate degree	15	Married
C6	Resident nurse	Associate degree	6	Single
C7	Resident nurse	Associate degree	6	Single
C8	Hospital director	Master's degree	25	Married
D1	CDC staff member	Bachelor's degree	10	Single
D2	CDC staff member	Bachelor's degree	14	Married
E1	Municipal Health Commission staff	Bachelor's degree	21	Married
E2	Municipal Health Commission staff	Bachelor's degree	30	Married
F1	Medical school professor	Doctoral degree	22	Married
F2	Medical school professor	Doctoral degree	34	Married
G1	Social worker	Bachelor's degree	8	Single
G2	Social worker	Master's degree	15	Married
G3	Social worker	Bachelor's degree	12	Single
G4	Social worker	Doctoral degree	20	Married
G5	Social worker	Associate degree	6	Single

insights for formulating effective strategies to prevent HIV transmission.

Study setting

M City was chosen as the study site due to its representation of the socio-economic and healthcare challenges prevalent in the region, particularly its limited resources and high HIV incidence. The city's diverse population and healthcare system offer a valuable context for exploring the integration of HIV care and prevention, making it an ideal location for this investigation.

By 2023, Yunnan reported an HIV incidence rate of 11.52 per 100,000, ranking fourth in China. Despite achieving a GDP of 3 trillion yuan, Yunnan remains underdeveloped, ranking 18 th among China's provinces, with limited resources for HIV prevention [22]. The province's 25 ethnic minorities face low health literacy, poor healthcare access, and high rates of injecting drug use, particularly among groups like the Jingpo, Dai, and Yi, driving the epidemic further.

Participants and sampling

A convenience sampling method was employed to select participants involved in the HIV prevention and treatment process [23].

A convenience sampling method was utilized to select participants involved in the HIV prevention and treatment process in Yunnan Province. The inclusion criteria were as follows: (1) Participants were residents of Yunnan Province; (2) Participants were aged between 18 and 65 years; (3) Participants were involved in any aspect of the HIV prevention and treatment process, including individuals living with HIV, medical staff from HIV treatment institutions, staff members from public health and disease control institutions, professors specializing in HIV prevention and treatment, and social volunteer workers; (4) Participants were able to demonstrate clear cognitive abilities; (5) Participants provided informed consent to participate in the interviews and investigation.

The exclusion criteria were: (1) Individuals who were not actively involved in the HIV prevention and treatment process; (2) Individuals with cognitive impairments or communication difficulties that would prevent them from providing informed consent or participating effectively in the study; (3) Participants who refused to provide informed consent or did not meet the requirements for participation.

Data collection

Between May 2024 and January 2025, a comprehensive review of regional HIV prevention and control literature and WHO guidelines was conducted, and in-depth interviews were carried out from August to December 2024.

Building on the research team's extensive experience in working with individuals living with HIV, an interview outline was developed to explore the multifaceted challenges encountered by government agencies, hospitals, grassroots medical institutions, and patients in HIV prevention and control along China's borders. Following a qualitative research framework, the interview outline was iteratively refined based on insights from prior interviews to enhance its relevance and depth. Semi-structured, one-on-one interviews were conducted by the research team, with each session lasting approximately 45 min. Prior to the formal data collection, a pre-interview was conducted with three experienced staff members from the M City CDC in Yunnan to refine the interview guide and ensure its relevance to the research topic. All interviews were audio-recorded with participants'consent and transcribed verbatim for subsequent analysis. The outline of our interviews is shown in the Appendix.

Three-level coding and theoretical saturation test

In this study, we adopted Grounded Theory methodology to analyze the challenges encountered in HIV prevention and treatment within M City, Yunnan Province. In this study, we employed a three-tiered coding process rooted in classical grounded theory methodology (as Fig. 2): open coding, axial coding, and selective coding. Five researchers, organized into two teams, conducted a meticulous line-by-line analysis of the interview transcripts, aiming to identify and summarize thematic codes representing diverse meanings. To ensure consistency and depth, the two teams met bi-weekly to discuss the similarities and differences between coding units and conducted monthly cross-team reviews and audits. This iterative process facilitated mutual feedback and resolution of coding discrepancies. Selective coding and core categories were subsequently extracted through an inductive-deductive approach [24].

Researchers independently examined the transcripts, assigning initial codes to segments that aligned with the research objectives. This phase focused on breaking down data into discrete parts to identify patterns and categories.

① Open Coding: Building upon the initial codes, the team explored relationships among categories, identifying conditions, actions, and consequences related to the phenomenon under study. This phase aimed to connect categories and subcategories, facilitating a deeper understanding of the data.

② Axial Coding: In this final stage, researchers synthesized the categories to construct a cohesive theoretical framework, identifying core categories that encapsulated the main concerns of participants. This process involved integrating and refining theories to explain the central phenomenon.

③ Selective Coding: To ensure consistency and depth in the coding process, the two teams met bi-weekly to discuss coding units, address discrepancies, and refine codes. Monthly cross-team reviews and audits were conducted to facilitate mutual feedback and resolve any coding discrepancies. This itera-

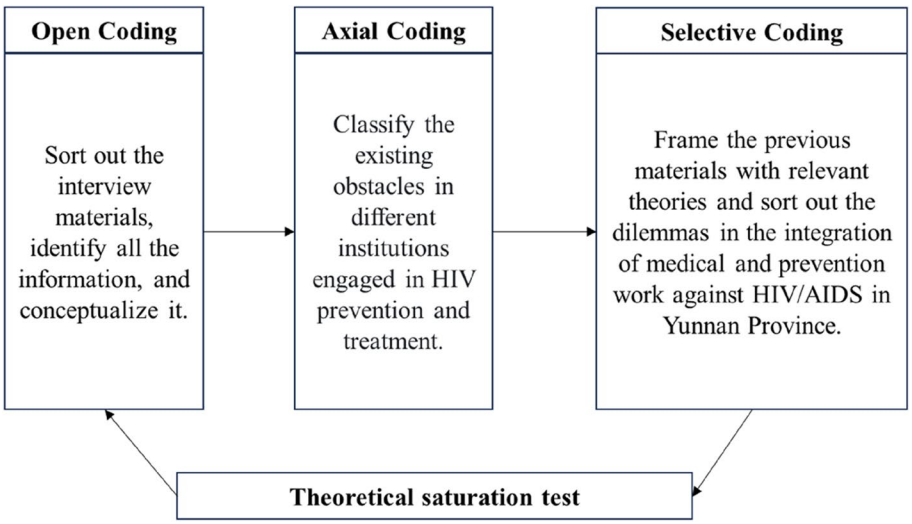

Fig. 2 The process of using grounded theory

tive process enhanced the rigor and trustworthiness of the analysis.

④ To ensure robustness, a theoretical saturation test was conducted. The research team re-examined the initial coding and interview transcripts to verify the comprehensiveness and depth of the analysis. Saturation was achieved by the 20 th interview, as no new concepts or categories emerged [23]. However, given the diversity in participant roles, coding continued for the remaining two interviews to ensure representational completeness and further comparison.

Research quality and trustworthiness

To ensure the triangulation of qualitative data and grounded theory, the following procedures were adopted in the study [25]. First, the interviews were conducted solely by the first author and corresponding author to increase consistency across interviews. Second, the analysis process involved multiple coders, and regular debriefing sessions were held to ensure unbiased analysis [26]. Third, constant comparison was employed to identify differences and similarities within the interview data of staff members from the same organization, particularly focusing on variations and similarities in the process and challenges of HIV prevention and treatment [27]. Fourth, the use of Nvivo 12 for verbatim transcription and coding enhanced the reliability and authenticity of the data. Fifth, the verbatim transcription process further ensured the dependability and accuracy of the data. Finally, three participants were randomly selected to participate in member checking, and two responded and engaged in the process.

In addition to the theoretical saturation test, the analysis adhered to Lincoln and Guba's criteria of trustworthiness, transferability, and confirmability [28]. First, Trustworthiness was ensured through six months of immersive fieldwork during data collection and analysis. Interviewers spent significant time building rapport and understanding participants'perspectives, while analysis included literature review, transcript coding, and regular team discussions. Second, Transferability was supported by detailing the methodology and situating participants'narratives within their lived experiences. Pseudonyms were used to maintain confidentiality. Third, Confirmability was demonstrated through a structured approach, including rigorous interview design, pre-interview briefings to ensure question clarity, and coding rooted in participants'real-world experiences of HIV prevention and control. Interviewers were professionally trained to minimize bias and avoid conclusions based on prior knowledge or assumptions.

Results

The research findings are organized into two main sections: First, a descriptive analysis of the 23 respondents is presented, followed by a detailed exploration of the results categorized through a three-level coding process based on various dimensions. These findings are further elaborated in the tables in the appendix, offering a comprehensive understanding of the challenges encountered by different stakeholders—government agencies, CDC, hospitals, primary healthcare institutions, and patients—throughout the HIV prevention and treatment process. The specific framework of the three-level coding is shown in Fig. 3.

Participant demographics

A total of 23 participants from Yunnan Province participated in this study, with ages ranging from 25 to 53 years (mean age: 39.65). Their personal information is detailed in Table 1. All interviewees demonstrated clear cognitive abilities and provided informed consent to participate in the interviews and the investigation.

Challenges of prevention HIV patients

Section 3.2 will outline the challenges faced by patients, village doctors, and hospitals in HIV prevention. Results analysis revealed six core categories: Challenges of prevention HIV patients in border areas, Difficulties for village doctors to screen at home, The dilemma of integration of HIV medical treatment and Prevention in frontier areas. Stable1-3 lists the categories and subcategories that occur, along with the corresponding number of participants and code. Below we show our main categories of concepts.

Patients'inattention to HIV prevention

Patients' inattention to HIV prevention is a widely discussed issue, as summarized in Stable 1 in the Appendix, which highlights several critical challenges, including the hidden nature of infection sources, non-adherence to antiretroviral therapy (ART) schedules, and migration patterns, particularly in Yunnan Province, where many rural residents seek employment outside their villages, exacerbating the spread of HIV to other provinces.

A key factor in patients'neglect of HIV prevention is the hidden nature of the sources of infection. *As respondent B1 noted: Compared to TB and Hepatitis B, the invisibility of the decline in health in HIV patients does prevent us from finding the source of the infection."This invisibility often delays detection and hampers timely interventions.*

Non-adherence to antiretroviral therapy (ART) schedules by infected individuals becomes a significant source of infection, especially in economically underdeveloped regions with high HIV incidence [29]. *Respondent C4*

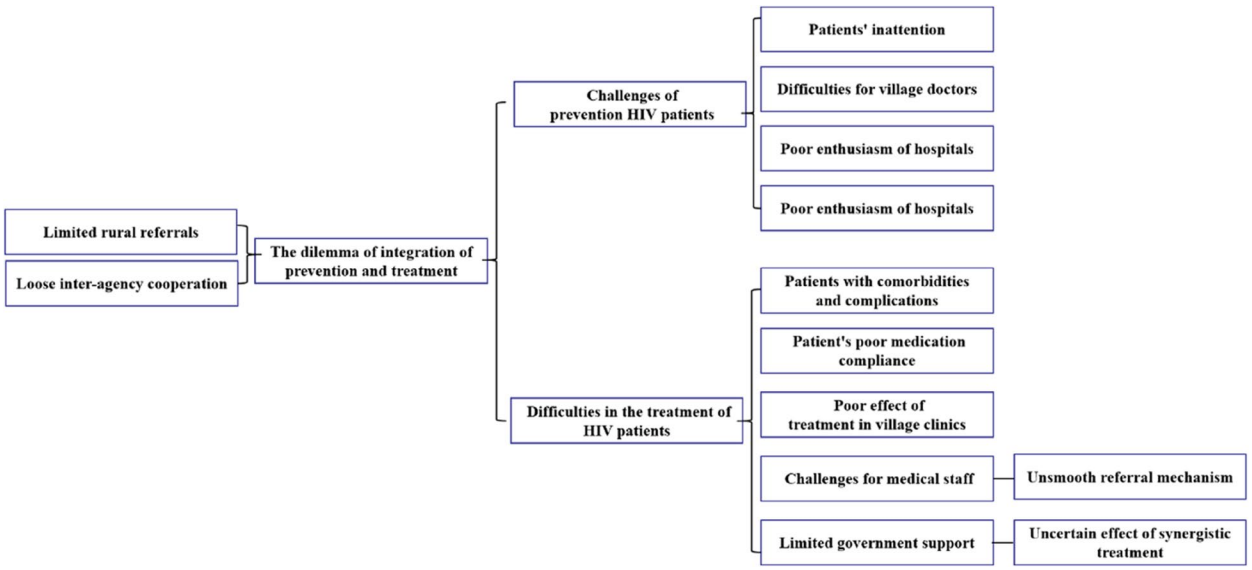

Fig. 3 Framework of the main results

emphasized: Not taking medication on time is harmful to the HIV patient's own body, and at the same time it has a high viral load, which is a very serious source of infection. If he takes his medication on time, his own level of health is basically similar to that of a normal person, and he also has a low viral load, which reduces the risk of infecting the patient."

Migration patterns, especially in Yunnan Province, where many rural residents seek employment outside their villages, exacerbate the spread of HIV to other provinces. *Respondent E1 illustrated this concern: "For example, if we lose a patient, or if he goes out to work, and then a very young patient becomes a source of infection in another province or region."*

Difficulties for village doctors to screen at home

Conducting on-site blood tests for HIV in remote, mountainous rural areas presents significant challenges for village doctors. These healthcare providers often serve large catchment areas encompassing hundreds of households, making logistical and resource-related barriers a substantial concern. *As C1 Mentioned:"The technical difficulty and high service cost of village doctors conducting home blood tests make patients reluctant to disclose their conditions to others in the village, leading them to refuse the doctor's home visit for blood testing."As respondent E1 explained: "Patients worry a lot about their privacy. They're afraid that if others find out about their condition, they'll be judged or talked about, so they often avoid going to the clinic or getting tested."*

One major issue is the personal risk and stigma associated with performing HIV testing in patients'homes [30]. Village doctors may face increased exposure risks, while community members often harbor fears about their HIV status being disclosed.

As respondent B2 explained:"It is impractical for village doctors to take blood at home to screen patients, both because patients do not trust them and because taking blood at home may expose them to HIV."

This dual challenge of logistical difficulties and social stigma highlights the need for enhanced systemic support, including better community education (as G5 mentioned), protective measures for healthcare providers, and infrastructure improvements to facilitate centralized testing and reduce the burden on village doctors.

Poor enthusiasm for HIV prevention and treatment in hospitals

In M City, the health education burden for HIV patients is excessive. *As respondent C8 noted:"Doctors should engage in giving more health education to some patients, which can promote the prevention of patients from infecting others, but now only hospital out-patient doctors are doing it. It is a heavy workload for 4 outpatients to be responsible for the health education of more than 1,9000 patients on a cumulative basis."*

This heavy workload underscores the pressing need for additional resources and support for health education programs (as G1 said), as well as strategies to decentralize and expand the workforce involved in HIV prevention efforts, as Stable1 in supplemental materials.

Difficulties in the treatment of HIV patients

This study will address several critical aspects: the variability in patients'conditions, suboptimal medication adherence, the limited effectiveness of on-site HIV treatment in rural clinics, the challenges faced by healthcare providers in delivering HIV treatment, the uncertain outcomes of synergistic therapies combining Traditional Chinese Medicine and Western medicine, and the limited government support for HIV programs.

Limited government support

> *"Right now, the government and the CDC mainly focus on setting performance targets—like how well hospitals and primary care centers retain patients—and checking whether they're meeting those goals." as mentioned by E1. However, financial support for these programs remains insufficient to meet the demands of comprehensive HIV care. As respondent C2 noted: "The main function of the government and the CDC is to assign indicators such as the rate of loss to hospitals and primary care institutions, and to complete the assessment of the indicators, with insufficient financial support."*

Variability in patients'conditions

The essence of HIV infection lies in the virus's assault on the immune system, especially CD4 + T cells. As CD4 cell counts decline, the immune system progressively loses its pathogen—resistance capacity, rendering patients susceptible to diverse opportunistic infections [31]. Such infections typically either do not occur or are mild in immunocompetent individuals but can be life—threatening in AIDS patients. When tuberculosis and AIDS infections occur concomitantly, it often gives rise to poor prognostic results [32]

Patients with comorbidities and complications represent some of the most severe cases, particularly when hospitalization becomes necessary. By this stage, patients often face advanced disease progression alongside significant comorbid conditions (as B1 mentioned). As respondent C4 explained:"*Like HIV, now with antiviral sub-drugs being effective, these patients'survival cycles are getting longer and longer. However, they inevitably develop comorbidities as they age—conditions such as hypertension, diabetes, heart attack, or cerebral infarction. Additionally, long-term medication use can lead to complications like osteoporosis and increased blood lipid levels. These issues often involve multiple medical specialties.*"

Patient's poor medication compliance

Low medication adherence among HIV patients was identified as a critical challenge by 15 respondents, highlighting a major barrier to effective HIV treatment in border regions.

> *"Despite the provision of free antiretroviral therapy (ART), regular follow-ups by medical personnel, and the home delivery of medications, instances of non-adherence and resistance to treatment persist. A contributing factor to poor adherence is the lack of family support. Weak familial ties can result in inadequate encouragement and monitoring of treatment.", as respondent D2 noted."A girl whose parents died in the family and who then became ill with HIV, but who has no other survival labour skills but to trade in sexual acts for a living, and who then trades out of the country and is difficult to trace. Her medication adherence is really poor—she often stops taking ART for long periods."*

This underscores the intersection of socio-economic vulnerability and treatment adherence challenges, where the absence of familial and economic stability exacerbates health outcomes. Additionally, disclosure of HIV status within families remains restricted. *As highlighted in respondent A2's account:"Hospitalized patients are forbidden to disclose their HIV status to family members, except in cases of serious life-threatening illness."* This lack of transparency can further undermine the support necessary for sustained treatment adherence.

It is difficult for participants from disease control centers to track their medication. Medication adherence among these individuals is significantly impacted by two key factors: the difficulty in tracking their treatment and the physical distance of their homes from medical institutions.

G2 has mentioned: Migrant workers often relocate frequently for employment, which complicates healthcare providers'ability to monitor their medication adherence and provide consistent follow-up care." Additionally, patients living far from healthcare facilities face logistical challenges in accessing medications and attending routine appointments, further reducing adherence rates.

Poor quality and limited effect of on-site HIV treatment in village clinics

In the mountainous areas of M City, Yunnan Province, the delivery of on-site HIV treatment services by village clinics faces severe constraints. The number of village doctors is limited, and the geographical dispersion of households makes home visits time-consuming and physically demanding. The lack of technical support and

human resources further weakens the capacity to provide standardized HIV care.

As respondent B2 noted, township health centers are primarily responsible for managing common chronic diseases such as diabetes and hypertension through home-based services, while specialists in infectious diseases and hematology are scarce. This shortage makes it extremely difficult to deliver professional HIV treatment at the community level, resulting in limited treatment coverage and quality in rural areas.

Challenges for medical staff to carry out HIV treatment

Strong privacy concerns among rural residents pose significant challenges to the provision of HIV health follow-up and treatment services by village doctors. Unlike conditions such as diabetes or hypertension, the stigma surrounding HIV leads to resistance in disclosing illness information or accepting home-based interventions.

As respondent A1 noted:"Unlike diabetes or high blood pressure, people living with HIV in the village do not want others to know that they have HIV, and resist disclosing information about their illness to the village doctor, as well as accepting blood tests and appropriate treatment at their home."A2 highlights that "Many patients are reluctant to disclose their HIV diagnosis to their relatives. This reluctance stems from concerns about stigma and discrimination. Consequently, the absence of family support significantly hampers their ability to manage the condition effectively. Without this support, patients often struggle to adhere to treatment plans, which can lead to a worsening of their condition and, ultimately, the progression to severe stages of the disease."

As respondent F2 explained: "It's hard for us to provide treatment in the village. People with HIV are very sensitive about their condition—they often hide it and don't want to be seen by others. They avoid home visits, don't want to do blood tests, and sometimes even refuse to talk to us. It's not like treating high blood pressure or diabetes—those patients are open and cooperative, but with HIV, there's a lot of fear and stigma."

This reluctance underscores the critical role of addressing stigma and confidentiality concerns to enhance access to HIV care in rural settings. Efforts to build trust and ensure privacy protections are essential to improving engagement with HIV prevention and treatment programs.

Uncertain effect of synergistic treatment between Chinese and Western medicine

The efficacy of Traditional Chinese Medicine (TCM) in treating HIV patients remains uncertain, particularly when used alongside antiretroviral therapy (ART). Self-administered TCM remedies have been reported to interfere with ART, potentially leading to adverse outcomes. As respondent C5 noted:"Hospitalised patients who have taken herbal medicines on their own will, on the contrary, antagonise the antiviral drugs, leading to abnormal liver and kidney function indices in patients with HIV."

The unsmooth referral mechanism

Referral for HIV treatment in rural areas remains difficult due to patients' reluctance, long travel distances, low financial incentives, and weak coordination between healthcare institutions.

As respondent D1 shared: "Even when we identify someone with HIV in the village, it's really hard to refer them to a higher-level hospital in the city. First, the distance is too far—some places take hours to get to. Second, many patients don't want to go. They're resistant, either because they're afraid of being seen or just don't trust the system. Plus, the travel reimbursement and financial incentives are too low—only a few dozen to a few hundred yuan. That's not enough to really encourage them."

B2 has mentioned:"There is a poor communication between medical institutions. M City is in the process of building a county-level medical community to improve healthcare integration. However, the collaboration between the Center for Disease Control (CDC), government agencies, designated medical institutions, and township health centers is not well established. There are no binding legal agreements in place, and the cooperation relies mainly on informal partnerships, which are coordinated through an online information platform."

The dilemma of integration of HIV medical treatment and prevention

In Sect. 3.4, we will focus on the following key points: the limited number of referrals from village clinics and township health centers, the loose collaboration between different institutions in HIV prevention and treatment, and the challenges in the integration of HIV prevention and treatment.

The number of referrals from village clinics and township health centers is small

Referral rates for HIV patients from village clinics and township health centers remain strikingly low. In the past year, only 36 HIV patients were detected in the district, and merely five of these cases were referred from township and village health centers. *As respondent C2 noted: "Most HIV cases aren't picked up or referred by village clinics—they either miss them completely or the patients don't want to go further. That's why only a handful get referred."*

Loose inter-agency cooperation

Inter-agency cooperation in managing HIV patients is weak, with limited sharing of patient health information between village health units and regional institutions such as township health centers and maternal and child health centers.

Respondent G2 noted that:"This lack of integrated health information systems creates barriers to coordinated care and effective case management, further complicating efforts to track and treat HIV patients across different levels of the healthcare system."

As respondent E2 emphasized: "It's really hard to manage patients this way. We can't see their full medical records, and there's no smooth way to communicate across institutions. Without a unified system, it feels like we're working in isolation."

Difficulties in the integration of HIV prevention and treatment

Figure 4 illustrates the multifaceted challenges in integrating HIV prevention and treatment in rural regions, emphasizing both patient-level and systemic barriers. Key issues include patients'inattention to HIV prevention, poor medication adherence, and logistical difficulties in accessing care, compounded by institutional challenges such as unsmooth referral mechanisms, limited government support, and weak inter-agency cooperation. Additionally, healthcare providers face significant hurdles, including a lack of enthusiasm for HIV prevention, resource constraints, and difficulties in managing complex cases with comorbidities and opportunistic infections. Together, these factors underscore the urgent need for coordinated, multisectoral interventions to address gaps in prevention, treatment, and institutional integration, ultimately enhancing the effectiveness of HIV treatment and prevention.

Discussion

Main findings

This study explores the intricate challenges of integrating HIV prevention, control, and treatment in M City, Yunnan Province—a resource-constrained, frontier mountainous region of China. The challenges faced in HIV prevention for patients mainly include: insufficient attention to HIV prevention by patients, difficulties for rural doctors in conducting screenings at patients'homes, and low enthusiasm for HIV prevention work in hospitals. As for HIV treatment, the challenges are more diverse and include: limited government support, patient condition diversity, poor patient medication adherence, unsatisfactory treatment outcomes in rural clinics, challenges faced by healthcare workers in providing HIV treatment, limited effectiveness of integrative treatments between Western and traditional Chinese medicine, and poor referral mechanisms between higher and lower-level institutions. The difficulties in the integration of HIV medical treatment and prevention include: low referral rates from rural clinics and township health centers, and loose cooperation between institutions.

Challenges in HIV prevention for patients in underdeveloped regions

HIV prevention has shifted from solely biomedical breakthroughs to include implementation and real-world

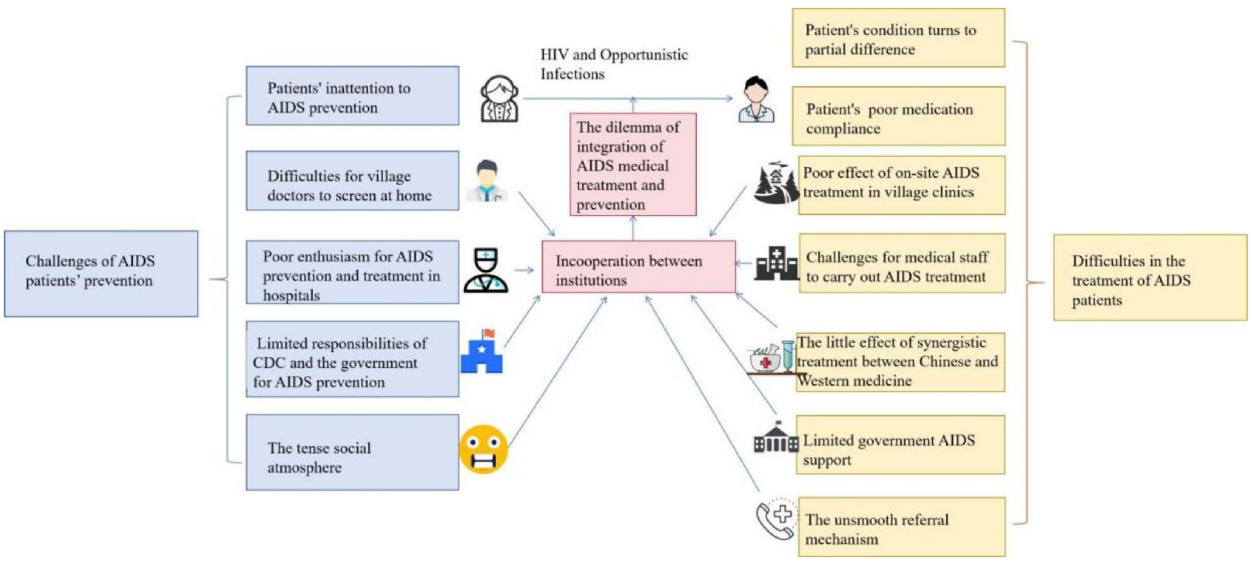

Fig. 4 The dilemma of integration of HIV treatment and prevention

effectiveness of combination strategies. Thus, interdepartmental collaboration and coordination among healthcare providers across different institutions and professional roles becomes particularly critical [33, 34]. The shortage of health education staff among village doctors and designated medical institutions in the local area has been identified as a major challenge in HIV prevention and control. It is important to draw lessons from the progress made in capacity building for HIV supply chain workers in Nigeria, where interventions by donor agencies have significantly contributed to enhancing the capacity of government personnel. Strengthening the economic support and performance incentives for doctors and nurses is crucial [35].

Additionally, drawing from the experience in Ethiopia, strengthening pre-service laboratory education can help build a sustainable talent pipeline and enhance the professional skills and competencies of healthcare workers [36]. Finally, enhancing the accessibility of pre-exposure prophylaxis (PrEP) remains essential. In the United States, for instance, the uptake of PrEP among young Black men in Alabama is reported to be below 5%, primarily due to structural barriers such as limited geographic access to clinics and inadequate insurance coverage. These findings closely parallel the access constraints observed in our study context [37].

In economically underdeveloped regions, the effectiveness of HIV prevention is largely constrained by limited public health funding. Evidence from Tanzania demonstrates that, although cost-effective biomedical interventions—such as the control of sexually transmitted infections (STIs)—have been identified, their integration into national HIV prevention frameworks is impeded by weak health infrastructure and chronic underfunding [38]. These challenges highlight the need for more sustainable, domestically supported strategies. Lessons can be drawn from the U.S. approach, which emphasizes the strategic allocation of HIV prevention resources to disproportionately affected populations—such as Black men who have sex with men (MSM), female sex workers, and people who inject drugs (PWID)—to enhance programmatic impact and equity [39]. The experience of rural Appalachia in the United States, where the"Gospel narrative"approach was employed for AIDS prevention education, offers valuable lessons. This initiative led to a significant increase in church participation, rising from 18 to 65%, and a notable 42% decline in the reported incidence of high-risk behaviors [40].

Challenges in HIV treatment for patients in underdeveloped regions

As an innovative model for comprehensive HIV/AIDS prevention and control in the new era, [41] the integration of medical treatment and public health services establishes a full-cycle intervention network, spanning from early screening to long-term management.For instance, the “clinical physician + public health physician” dual consultation model piloted in Wuxi,China [42] assigns clinical teams to formulate antiretroviral therapy (ART) regimens, while public health physicians lead epidemiological investigations and high-risk population follow-up, effectively reducing the referral time for newly diagnosed patients to within 24 h.

This collaborative mechanism has been shown to improve treatment adherence by 28% in integrated care practices in Romania [43].

The study identifies key barriers to effective HIV treatment in underdeveloped regions, including patients’ low health awareness, hidden infection sources, increasing MSM populations, and limited condom use. Despite free medication, electronic pillboxes, and home delivery, poor adherence persists due to stigma, weak family support, and financial strain. Systemic challenges such as overstretched healthcare staff, unmotivated institutions, and limited collaboration across village clinics, health centers, and CDCs further hinder HIV prevention and intergrated care delivery.

Weak rural healthcare infrastructure remains a major barrier to effective HIV treatment. In many rural areas, there is a general shortage of specialized HIV physicians and viral load testing equipment.For example, in the United States, only 20% of individuals co-infected with HIV and HCV in rural regions affected by opioid misuse were able to access antiretroviral therapy, compared to 60% in urban settings [44]. In China, the implementation of a three-tiered “county-township-village” HIV prevention and control model in rural Guangxi Province successfully increased the viral suppression rate from 68% in 2011 to 92% in 2017 [45].

However, inadequate training of primary healthcare providers continues to limit the coverage and quality of HIV services at the grassroots level. Stigma and resistance remain key barriers to effective HIV diagnosis and treatment. In rural South African communities, for instance, AIDS-related deaths are often attributed to “curses,” leading to low willingness to undergo testing and treatment [46]. In ethnic minority regions of central and western China, language barriers hinder the effectiveness of traditional media-based health education [47]. Meanwhile, the reliability of health information disseminated via social media is inconsistent, contributing to limited HIV-related health literacy among patients.

In economically underdeveloped regions, poor patient adherence is considered the greatest challenge in HIV treatment, driven by several key factors. Social discrimination and stigmatization persist, significantly affecting

patients'willingness to undergo testing and treatment, particularly among people who inject drugs (PWID) [48]. For example, a harm reduction program in Miami, Florida, demonstrated that remote harm reduction interventions could reduce the stigma typically associated with traditional healthcare settings, thereby improving engagement in care and enhancing connections with HIV-positive People Who Inject Drugs [49].

Furthermore, concerns about privacy breaches deter patients from participating in integrated care programs, such as community follow-up and teleconsultations.The economic burden exacerbates non-adherence, as even though treatment is free, transportation and nutritional costs remain significant barriers [50]. Mental health issues, particularly anxiety and depression, negatively impact treatment adherence and quality of life, and the lack of adequate psychological support services worsens this situation [51]. Finally, cultural differences influence patients'perceptions and attitudes toward HIV, affecting their acceptance of integrated care services.

Predicaments in achieving HIV medical prevention integration

The findings also underscore the limited success in achieving integration between HIV healthcare and prevention. Currently, the responsibility for HIV prevention and treatment largely falls on hospital infection departments, while other institutions play a minimal role. This lack of coordination hinders the development of a comprehensive healthcare and prevention framework, limiting the effectiveness of HIV management in impoverished areas.

Primary healthcare (PHC) plays a critical role in delivering health services in resource-constrained areas, yet its potential remains underutilized in HIV prevention and control [52, 53]. Village and township health centers are capable of initiating antiretroviral therapy early, but their effectiveness is limited by practical challenges [54, 55], including the inability to conduct home blood tests or provide health counseling without risking patient privacy [56, 57]. This lack of capacity increases the economic burden on patients, who must travel to urban healthcare facilities, while simultaneously overwhelming urban healthcare institutions.

Another major challenge is the lack of smooth referral mechanisms between hospitals and primary care institutions. Inefficiencies in this system delay patients'access to timely care [58, 59], which is particularly concerning given the rise in HIV patients with comorbidities and opportunistic infections. Establishing multidisciplinary team (MDT) interventions for such patients is crucial [60]. Lessons from Denmark show that implementing HAART (Highly Active Antiretroviral Therapy) early and ensuring seamless referral through robust information platforms can significantly reduce morbidity and mortality among HIV patients.

The structural challenge in mainstreaming HIV in Ethiopia's regional sectors was consistently highlighted, with a key issue being the lack of effective communication and collaboration between regional, zonal, and district-level sectors. This gap in coordination hindered the flow of strategic plans, guidelines, and feedback from lower-level sectors, resulting in inequities in HIV services and leaving communities without essential support. Both male and female participants reflected on these challenges [61].

Additionally, healthcare professionals in designated institutions face low motivation due to insufficient financial and institutional support. Providing adequate financial incentives and recognition for infectious disease staff is essential to enhancing their dedication and improving patient care. Empowering healthcare workers with proper rewards and resources can foster a more compassionate and effective healthcare environment for HIV patients [62].

Limitations

This study has several limitations. First, its geographic scope is narrow, as the research was conducted exclusively in a border region of Yunnan Province, China. The findings may not be generalizable to other regions with different economic and socio-cultural contexts. Second, the sensitive nature of HIV-related topics may have affected participants'willingness to disclose information fully, potentially limiting the accuracy of some responses. Lastly, the number of interviews conducted was relatively small due to privacy concerns, which restricted our ability to recruit a broader sample of local HIV patients.

Conclusion

This study reveals the multifaceted challenges in HIV prevention, control, and treatment in economically underdeveloped regions. These challenges involve patient behaviors, the limitations of rural doctors, the inefficiency of healthcare institutions, and shortcomings in coordination and policy support systems. The integration model for healthcare and prevention holds promise for addressing these issues, but substantial efforts are needed to build a collaborative framework that includes multiple stakeholders.

The construction of the HIV medical prevention integration framework needs to focus on several key areas: 1) cultivating patients'self-health awareness and preventive behaviors, 2) village doctors and grassroots healthcare institutions should work to reduce the stigma for rural patients and use health education to

encourage greater family support, 3) hospitals should improve referral systems, increase financial incentives for healthcare workers, ensure reduced infection risks for staff, and enhance their enthusiasm for participating in prevention and treatment efforts, and 4) leveraging technological innovations, such as electronic monitoring devices, is crucial in advancing HIV care in resource-limited settings. In Yunnan Province, various regions have begun building big data platforms for HIV tracing and molecular network analysis, which effectively identify and record new cases, enabling trace-based prevention and control.

Future research should expand its scope by conducting multi-center and longitudinal studies across different countries and regions. Additionally, implementation research is essential to assess how the integration model can be applied in real-world settings, ensuring its scalability and sustainability. In conclusion, the integration framework requires effective coordination of resources from the government, disease control centers, hospitals, township health centers, patients, families, village doctors, and healthcare personnel. This coordinated effort plays a crucial role in improving HIV prevention, screening, diagnosis, and treatment in economically disadvantaged regions.

Abbreviations

ART	Antiretroviral Therapy
CDC	Center for Disease Control
HAART	Highly Active Antiretroviral Therapy
GT	Grounded Theory
GDP	Gross Domestic Product
HIV	Human Immunodeficiency Virus
MDT	Multidisciplinary Team
MEMS	Medication Event Monitoring System
MSM	Men Who Have Sex with Men
PHC	Primary Healthcare
STIs	Sexually Transmitted Infections
TCM	Traditional Chinese Medicine

Supplementary Information

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Supplementary Material 1

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Authors' contributions

Sixian Du contributed to the conceptualization, methodology, data analysis, and manuscript writing. Haoran Niu contributed to the literature review and data interpretation. Feng Jiang, Liwen Gong, Shan Zheng, Qi Cui, and Xu Yang contributed to data collection and provided critical revisions to the manuscript. Jiayan He, Rongcai Dai, Qilian Luo, and Yiqing Yang were involved in the literature review and provided feedback on the manuscript draft.

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Data availability

The datasets used during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the ethical standards laid out in the 1964 Declaration of Helsinki, and its later amendments or comparable ethical standards. The study was submitted to and approved by the Ethics Committee of Tongji Medical College, Huazhong University of Science and Technology. The approval reference number is 21YJA630062. All participants provided informed consent to participate in the study.

In this study, the need for ethics approval was deemed necessary, and the approval was obtained from the Ethics Committee of Tongji Medical College, Huazhong University of Science and Technology (Ethics Committee Office: Room 1612, Building No. 2, Tongji Medical College, 13 Hangkong Road, Qiaokou District, Wuhan, Hubei, China; Phone: 027–83691785; E-mail: tongjilunli@163.com).

The study strictly adhered to ethical principles throughout the research process. Informed consent was obtained from all participants, and their privacy and confidentiality were ensured. The study involved no interventions or risks to participants, and all data were anonymized to protect participant identities.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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