Jurnal Ilmu Kesehatan dan Kebidanan Nusantara (JIKKN)
Volume 3, Number 4, 2026
E-ISSN: 3047-9584
Open Access: https://teewanjournal.com/index.php/jikkn/index

HIV TESTING UPTAKE AND DELAYED DIAGNOSIS IN UNDERSERVED COMMUNITIES: A SCOPING REVIEW OF EPIDEMIOLOGICAL AND HEALTH-SYSTEM DETERMINANTS

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ARTICLE INFO

Article history:
Received: 14-09-2026
Revised: 11-10-2026
Accepted: 20-10-2026
Available online: 30-10-2026

Kata Kunci:
Aksesibilitas Layanan Kesehatan, Diagnosis Terlambat, Populasi Rentan, Tes HIV, Tinjauan Pelingkupan

Keywords:
Delayed Diagnosis, Health Services Accessibility, HIV Testing, Scoping Review, Vulnerable Populations

ABSTRAK

Diagnosis *human immunodeficiency virus* (HIV) yang terlambat masih sering terjadi, dan komunitas kurang terlayani memiliki kesempatan yang tidak setara untuk menjalani tes. Tinjauan ini bertujuan memetakan determinan epidemiologis, sosiodemografis, perilaku, struktural, dan sistem kesehatan terhadap cakupan tes HIV dan keterlambatan diagnosis pada komunitas kurang terlayani, serta membandingkan determinan kedua luaran tersebut. Tinjauan pelingkupan ini mengikuti panduan Joanna Briggs Institute dan ekstensi PRISMA untuk tinjauan pelingkupan. Sumber telaah sejawat terbitan 2021–2026 diidentifikasi melalui mesin pencari web dan penelusuran sitasi (20 Oktober 2026), bukan melalui pelaksanaan pencarian di basis data bibliografis. Dari 53 laporan yang dinilai kelayakannya, 26 sumber diikutsertakan (22 studi primer dan 4 tinjauan) dari Afrika Sub-Sahara, Eropa, Asia, dan Amerika Utara. Cakupan tes lebih rendah pada laki-laki, remaja dan dewasa muda, kelompok berpendidikan rendah, rumah tangga miskin, komunitas dengan tingkat buta huruf tinggi, serta orang dengan stigma atau sikap diskriminatif. Proporsi diagnosis terlambat yang dilaporkan berkisar 17,6–67,9%, tetapi angka tersebut tidak dapat dibandingkan secara langsung karena definisi (ambang CD4, diagnosis AIDS, dan jendela waktu) serta populasi studi berbeda. Berbeda dari rendahnya cakupan tes pada kelompok usia muda, keterlambatan diagnosis lebih banyak dikaitkan dengan usia lebih tua, transmisi heteroseksual, migrasi, dan kesempatan pemeriksaan yang terlewat pada kontak layanan kesehatan sebelumnya. Determinan cakupan tes dan keterlambatan diagnosis saling tumpang tindih tetapi tidak identik. Penawaran tes berbasis indikator klinis yang tidak semata-mata bergantung pada persepsi risiko, replikasi berbasis basis data bibliografis, dan definisi luaran yang seragam diperlukan.

ABSTRACT

Late diagnosis of human immunodeficiency virus (HIV) infection remains common, and underserved communities have unequal opportunities to be tested. To map epidemiological, sociodemographic, behavioural, structural and health-system determinants of HIV testing uptake

and delayed diagnosis among underserved communities and to compare determinants across the two outcomes. This scoping review followed Joanna Briggs Institute guidance and the PRISMA extension for scoping reviews. Peer-reviewed sources published 2021–2026 were identified through a web search engine and citation chasing (20 October 2026); searches were not executed in bibliographic databases. Of 53 reports assessed for eligibility, 26 sources were included (22 primary studies, 4 reviews) from sub-Saharan Africa, Europe, Asia and North America. Testing uptake was lower among men, adolescents and young adults, less educated people, poorer households, communities with high illiteracy, and people reporting stigma or discriminatory attitudes. Reported proportions of late diagnosis ranged from 17.6% to 67.9%, but these figures are not directly comparable because definitions (CD4 threshold, AIDS diagnosis and time window) and study populations differed. In contrast to low testing uptake among younger people, delayed diagnosis was linked mainly to older age, heterosexual transmission, migration and missed testing opportunities at earlier health-care contacts. Determinants of uptake and delay overlap but are not identical. Test offers guided by clinical indications rather than perceived risk alone, database-based replication and common outcome definitions are needed.

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INTRODUCTION

HIV testing is the entry point to treatment and prevention, yet a diagnostic gap persists. According to the UNAIDS 2026 epidemiological estimates, released in July 2026 and referring to the end of 2025, 41.0 million people were living with HIV, 88% knew their status and about 5.0 million did not; status awareness was lower among adult men (86%) than among adult women (91%) (UNAIDS, 2026). The World Health Organization recommends differentiated testing, including self-testing and network-based approaches, to reach people missed by facility-based services (World Health Organization, 2024).

Two related but distinct outcomes describe this gap. *Testing uptake* refers to ever, recent or repeat testing and measures service reach. *Delayed diagnosis* refers to the stage at which infection is detected among people already living with HIV. The updated European consensus defines late diagnosis as a CD4 count below 350 cells/µL or an AIDS-defining event at diagnosis, excluding people with evidence of recent infection (Croxford et al., 2022). Late presentation to care and advanced HIV disease are measured at different points and thresholds. In Germany, for example, national surveillance and clinical cohort analyses published in 2012, and summarised in a 2023 review, estimated late diagnosis at 49.5% but late presentation at 58.1% (Boesecke et al., 2023); these figures describe the earlier data period, not 2023. Treating these terms as interchangeable obscures where in the pathway the failure occurs.

Underserved communities, including rural residents, migrants, poorer households, older adults, young people and key populations, may experience both lower uptake and later diagnosis, but not necessarily for the same reasons. Previous evidence syntheses have

each covered one part of this problem. Owusu et al. (2023) systematically reviewed barriers to HIV testing among migrant women in Europe and described individual, sociocultural and structural barriers, but their review was limited to one population and one region and did not examine determinants of diagnostic timing quantitatively. Kitenge et al. (2023) meta-analysed the prevalence of advanced HIV disease among antiretroviral therapy-naive and therapy-experienced people in South Africa from studies published between 2010 and 2022; their focus was prevalence in one country, and advanced disease combines late diagnosis with disengagement from care. Jamil et al. (2021) pooled randomised trials showing that HIV self-testing increased uptake in general populations, mostly in sub-Saharan Africa, but did not address who remains untested or is diagnosed late. Boesecke et al. (2023) summarised late diagnosis in Germany in an expert narrative review without a systematic search.

Earlier reviews were therefore restricted to one outcome, population, country or intervention, and none examined how determinants operate across successive stages from contact with services to diagnosis. The present review contributes by integrating determinants across three linked stages: the *opportunity to be tested* (a health-service contact at which a test could be offered or requested), *test uptake* (whether people are tested) and the *timing of diagnosis* (whether infection is detected late). Examining the three stages together shows whether the factors that keep people from testing are the same factors that delay diagnosis, or whether different mechanisms operate, which has different implications for services. A scoping review suits this heterogeneous evidence because the aim is to map rather than pool effects (Peters et al., 2021).

The objectives of this review were to (1) describe the volume and characteristics of peer-reviewed evidence published in 2021–2026 on HIV testing uptake and delayed diagnosis among underserved communities; (2) identify the reported determinants of each outcome and classify them into six socio-ecological levels; (3) classify each determinant as shared, mainly related to uptake or mainly related to delay; (4) describe how missed opportunities for testing were defined and measured; and (5) identify evidence gaps across pathway stages, populations and regions.

METHODS

Design and Reporting

The review followed Joanna Briggs Institute (JBI) scoping review guidance (Peters et al., 2021; Pollock et al., 2023). Reporting was structured with reference to the PRISMA extension for scoping reviews (PRISMA-ScR); because the checklist predates the reference

window of this manuscript, it is not cited, and compliance is mapped in Supplementary Table S6. Search reporting followed PRISMA-S principles (Rethlefsen et al., 2021). No protocol was registered. The primary question was: what epidemiological, sociodemographic, behavioural, structural and health-system determinants of HIV testing uptake and delayed HIV diagnosis have been reported among underserved communities? Five sub-questions corresponded to the five objectives: (RQ1) what are the characteristics of the evidence; (RQ2) which determinants, at which levels, are associated with each outcome; (RQ3) which determinants are shared and which are outcome-specific; (RQ4) how are missed opportunities defined and measured; and (RQ5) where are the evidence gaps?

Eligibility Criteria

Eligibility was defined before screening using the Population–Concept–Context framework (**Table 1**). Sources had to be peer-reviewed, published 2021–2026 and in English; non-significant associations were eligible. Each source's definition of delay was retained, and testing uptake, late diagnosis, late presentation, advanced HIV disease and missed opportunities were charted as separate outcomes.

Table 1. Population–Concept–Context framework and eligibility criteria

Component	Inclusion	Exclusion
Population	Underserved groups meeting at least one predefined category (socioeconomic, geographic, migration, age, men in settings with a male testing gap, WHO key populations, groups not prioritised by risk-based testing), as the whole sample or as a disaggregated subgroup	General populations without a disaggregated estimate for any predefined category (three contextual exceptions are described in the text)
Concept: testing uptake	Ever, recent or repeat testing; provider-initiated, community or self-testing uptake	Test accuracy only
Concept: delayed diagnosis	Late diagnosis, late presentation, advanced HIV disease or missed opportunities, each charted with the source definition and measurement point	Post-linkage outcomes only
Determinants and context	Any epidemiological to health-system determinant; any country or setting	Prevalence without determinants
Sources	Peer-reviewed primary studies and reviews; English; published 2021–2026 (data may predate 2021)	Grey literature; unverifiable records; published before 2021

Rationale for the publication window. The window 2021–2026 was chosen for three reasons. First, it covers the period after WHO recommendations on HIV self-testing and differentiated testing were widely adopted and after the COVID-19 pandemic disrupted

testing services, so that recent analyses of these service changes could be captured (Jamil et al., 2021; World Health Organization, 2024). Second, it overlaps with the updated European consensus definition of late diagnosis (Croxford et al., 2022), allowing the definitions used in recent studies to be compared with a current reference standard. Third, earlier literature had been covered by previous reviews, and the aim was to map recent evidence rather than the full historical literature. The window applies to the publication date only. Because many studies analysed data collected years earlier, the data-collection period of each source was charted separately (**Table 2**), and estimates are attributed to the years in which the data were collected rather than to the year of publication.

Operational definition of underserved communities. A population was classified as underserved when the whole sample, or a subgroup for which a separate estimate was reported, belonged to at least one of seven predefined categories with documented disadvantage in access to HIV testing or timely diagnosis: (a) socioeconomic disadvantage (lower wealth quintiles, low educational attainment, low-income households or no health insurance); (b) geographic disadvantage (rural residence or communities with high illiteracy or poverty); (c) migration (foreign-born people, migrants or refugees); (d) age groups with known service gaps (adolescents and young adults aged 15–24 years, and adults aged 50 years or older); (e) men in settings where testing coverage or status awareness among men is lower than among women; (f) key populations defined by WHO (men who have sex with men, sex workers, people who inject drugs, transgender people and people in prisons); and (g) groups not prioritised by risk-based testing, such as heterosexual adults and women in settings where testing targets key populations. Status was determined in two steps: the reviewer first recorded how the source described its population and then checked whether that population, or an analysed subgroup, matched one of the categories. Terms such as ‘vulnerable’, ‘marginalised’ or ‘hard-to-reach’ were accepted only when the group also matched a category. The category assigned to each source is shown in **Table 2**.

Sources based on general populations. Studies of general populations were eligible when they reported a disaggregated estimate (a stratum-specific proportion or an association) for at least one predefined underserved category, for example by wealth quintile, residence, migrant origin or age group. Only these disaggregated findings were charted and synthesised; pooled general-population estimates were used only as descriptive context. Three sources did not report such estimates (Jamil et al., 2021; Kitenge et al., 2023; Isosomppi et al., 2025). They were retained because they provided the only eligible evidence on, respectively, testing modality, advanced disease in a high-burden public-sector setting

and health-care use before diagnosis. They are flagged as contextual sources in Table 2, and their findings are interpreted as context rather than as group-specific evidence.

Distinguishing outcome constructs during charting. Each outcome was charted according to the definition and measurement point reported by the source rather than by its label alone. Late diagnosis was charted when CD4 count or AIDS status was measured at, or shortly after, a first HIV diagnosis (for example, CD4 <350 cells/μL within six months, or AIDS within 90 days), with or without exclusion of recent infection (Croxford et al., 2022). Late presentation was charted when the same thresholds were applied at entry into HIV care, which may include people diagnosed earlier who entered care late. Advanced HIV disease was charted when a CD4 count below 200 cells/μL or WHO clinical stage 3 or 4 disease was used, irrespective of whether people were newly diagnosed, re-engaging or treatment-experienced. Missed opportunities were charted as a process measure, namely a health-care encounter before diagnosis without an HIV test, and were further classified as contact-based (any encounter counted) or indication-based (only encounters at which testing was indicated by a guideline, an indicator condition or a clinical criterion). When a source's label and definition disagreed, the definition determined the category and the original label was recorded in Supplementary Table S2.

Information Sources, Selection and Charting

Bibliographic database interfaces (PubMed/MEDLINE, Scopus, Web of Science, Embase, CINAHL and Global Health) were not accessible, and no database search was executed. The search was conducted on 20 October 2026 with a general web search engine using 34 queries (10 discovery queries and 24 retrieval or verification queries), supplemented by backward citation chasing. The search engine returned approximately 340 result entries, which were screened at title and snippet level but not individually enumerated; 44 reports were sought from this source, and citation chasing identified 9 further reports (Figure 1). Bibliographic details were verified against PubMed Central, publisher pages or institutional repositories. Queries are listed verbatim in Supplementary Table S1, together with complete database strategies prepared for replication but not yet executed. One reviewer screened entries, assessed reports and recorded exclusion reasons. Data were charted on setting, design, data-collection period, population, sample size, underserved category, outcome definition and measurement point, determinants, effect estimates with adjustment status, qualitative themes and limitations, from full texts where accessible and otherwise from abstracts.

Synthesis

Quantitative and qualitative evidence were synthesised separately and were brought together only in the comparison across outcomes. No meta-analysis, causal inference or critical appraisal was undertaken, consistent with scoping review methodology (Pollock et al., 2023). Ethical approval was not required.

Quantitative synthesis. Sources were counted by region, design, population and outcome (Supplementary Figure S1). Proportions and effect estimates were tabulated as published, with adjusted estimates preferred over unadjusted ones and the data-collection period recorded. Because definitions, measurement points and populations differed, proportions of late diagnosis were not ranked or compared directly across sources.

Qualitative synthesis. Findings from qualitative studies and the narrative components of reviews were analysed with basic qualitative content analysis (Pollock et al., 2023). Text segments describing reasons for not testing, for not being offered a test or for late diagnosis were coded deductively to the six levels and then inductively within levels to generate descriptive themes.

Grouping into six levels. Each determinant was assigned to one of six levels adapted from the socio-ecological model, according to the unit at which the variable was measured or operated: (1) individual and epidemiological (personal characteristics, knowledge, risk behaviour, transmission route); (2) interpersonal and household (marital status, partner HIV status, household composition); (3) community and sociocultural (community-aggregated variables, stigma and discriminatory attitudes, norms); (4) structural and socioeconomic (household wealth, rurality, migration and legal status); (5) health system and service delivery (health insurance, testing modality, offer of testing, referral and missed opportunities); and (6) policy and governance (laws, guidelines and financing). Household wealth was coded as structural because it reflects socioeconomic position, whereas health insurance was coded as a health-system factor because it determines financial access to services. Ambiguous variables were assigned to the most proximal level at which they were measured, and each coding decision was recorded in Supplementary Table S2.

Shared and outcome-specific determinants. A determinant was classified as shared when at least one source reported evidence (a quantitative association or a qualitative theme) linking it to testing uptake and at least one linked it to delayed diagnosis (late diagnosis, late presentation, advanced disease or missed opportunity). It was classified as shared with opposite direction when the same characteristic, such as age, was linked to disadvantage at opposite ends of its range for the two outcomes. It was classified as mainly uptake-related or mainly delay-related when evidence existed for only one outcome; this label shows

where evidence exists and does not imply that the factor is irrelevant to the other outcome. Determinants with conflicting directions within one outcome, or supported only by unadjusted estimates, were classified as inconsistent or insufficient.

RESULTS AND DISCUSSION

Selection and Characteristics of Sources

The web search engine returned approximately 340 result entries, from which 44 reports were sought after title and snippet screening; citation chasing identified 9 further reports. No records came from bibliographic databases because database searches were not executed. All 53 reports sought were retrieved and assessed for eligibility. Of these, 27 were excluded because bibliographic details could not be verified (n = 12), publication preceded 2021 (n = 6), the report was not peer reviewed (n = 4), insufficient data were retrievable (n = 4) or the outcome was outside the scope (n = 1) (**Figure 1**). Twenty-six sources, each represented by one report, were included: 22 primary studies and 4 reviews (Table 2).

Sources were published 2021–2026 and came from sub-Saharan Africa (n = 11), Europe (n = 8), Asia (n = 4), North America (n = 2) and multi-regional trials (n = 1). Designs comprised surveys (n = 11; ten population-based household surveys and one cross-sectional survey), surveillance, register or cohort analyses (n = 9), qualitative studies (n = 2) and reviews (n = 4). Twelve sources addressed testing uptake, 13 late diagnosis, late presentation or advanced disease, and 4 missed opportunities; some sources addressed more than one outcome (Supplementary Figure S1). Although all sources were published from 2021 onwards, many analysed data collected much earlier, for example 1981–2019 in a European cohort database (Miranda et al., 2021) and 2015–2016 in southern African household surveys (Haas et al., 2022) (**Table 2**). Definitions of delay ranged from a CD4 count below 350 cells/µL (Haas et al., 2022; Reyes-Urueña et al., 2025) to an AIDS diagnosis within 90 days (Gibas et al., 2024), precluding direct comparison of prevalence.

Table 2. Characteristics of included sources (n = 26)

Source	Setting	Design; data period	Population (n)	Underserved category	Outcome and definition
Adugna & Worku, 2022	11 eastern African countries	Multilevel analysis of DHS; 2011–2018	Men 15–64 y (113,270)	(e) men; (b) rural, high-illiteracy communities	Uptake: ever tested
Alem et al., 2022	Ethiopia	Multilevel analysis of DHS; 2016	Women 15–49 y (14,599)	(a) poorer, less educated; (b) rural	Uptake: ever received HIV counselling and testing
Ijaiya et al., 2024	10 sub-Saharan African countries	Bayesian multilevel analysis of DHS; NR	Men 15–49 y (52,641)	(e) men; (b) rural, high-illiteracy communities	Uptake: ever tested

Source	Setting	Design; data period	Population (n)	Underserved category	Outcome and definition
Jooste et al., 2021	South Africa	National household survey (SABSSM); 2017	People ≥15 y, by household SES (NR)	(a) low-income households; (b) rural	Uptake: ever tested
Jude et al., 2021	Uganda	National DHS; 2016	Sexually active men 15–54 y (4,168)	(e) men; (a) low education	Uptake: never tested
Musonda et al., 2023	18 sub-Saharan African countries	Pooled DHS; 2015–2020	Never-married young men 15–24 y (NR)	(d) young people; (e) men	Uptake: tested in the past 12 months
Sabo et al., 2024	13 sub-Saharan African countries	Multilevel analysis of DHS; 2015–2022	Adults 15–64 y (283,936)	General population with strata for (a), (b), (e)	Uptake: ever tested
Tetteh et al., 2022	29 sub-Saharan African countries	Multilevel analysis of DHS; NR	Men (104,398)	(e) men; (a) low knowledge, education	Uptake: ever tested
Worku et al., 2022	11 eastern African countries	Multilevel analysis of DHS; 2008–2018	Women 15–24 y (73,661)	(d) young women	Uptake: ever tested
Sidjabat et al., 2024	Semarang, Indonesia	Cross-sectional survey; NR	MSM who had tested (300)	(f) MSM	Uptake: testing on personal initiative vs invitation
Haas et al., 2022	Malawi, Zambia, Zimbabwe	PHIA household surveys; 2015–2016	Adults newly diagnosed in the surveys (1,804)	(e) men; (d) older adults	Late diagnosis: CD4 <350 at survey diagnosis
Reyes-Urueña et al., 2025	23 EU/EEA countries	Surveillance; 2022–2024	New diagnoses (28,521)	(c) migrants; (d) older adults; (g) heterosexual people	Late diagnosis: CD4 <350 within 6 months or AIDS; recent infection excluded from numerator
Isosomppi et al., 2026	Finland	National register cohort; 2008–2023	New diagnoses in adults (1,813)	(c) migrant women; (d) older adults; (g) heterosexual people	Late diagnosis: updated consensus definition
Miranda et al., 2021	Europe (EuResist database)	Cohort database; 1981–2019	People with HIV-1 (89,851)	(d) older; (c) African-born; (g) heterosexual	Late presentation: CD4 <350 or AIDS at presentation
Gibas et al., 2024	Tennessee, USA	Surveillance cohort; 2015–2019	Adults ≥18 y newly diagnosed (3,652)	(b) rural residents; Hispanic people	Late diagnosis: AIDS within 90 days of HIV diagnosis
Su et al., 2024	Hunan, China	Surveillance; 2018–2021	New diagnoses (22,504)	(d) older adults; (a) low education; (b) western regions	Late diagnosis: low CD4 count or AIDS at diagnosis
Tang et al., 2025	Wuhan, China	Retrospective surveillance analysis; 2023	New diagnoses (383)	(d) older adults; (g) heterosexual people	Late diagnosis: CD4 <350; AHD: CD4 <200
Wong et al., 2024	Malaysia	Qualitative interviews; NR	Older people with HIV and providers (NR)	(d) older adults	Late testing and diagnosis (participant accounts)

Source	Setting	Design; data period	Population (n)	Underserved category	Outcome and definition
Bedert et al., 2021	Amsterdam, Netherlands	Qualitative interviews; 2019–2020	People diagnosed late (14)	(f) MSM; (c) migrants	Late diagnosis: CD4 ≤350 at diagnosis
Paer et al., 2023	New York City, USA	Retrospective single-centre cohort; 2018–2022	Newly diagnosed people (260)	(a) low-income, mainly Hispanic catchment; (g) women, heterosexual people	Missed opportunity, contact-based: 365 days (Table 4)
Isosomppi et al., 2025†	Finland	National register study; 2011–2019	People newly diagnosed (907)	Contextual: all new diagnoses	Health-care contacts before diagnosis; indicator conditions (Table 4)
Lourinho et al., 2024	Portugal	Retrospective single-centre cohort; 2018–2023	Adults newly diagnosed or treatment-naive (436)	(c) African-born migrants; (g) women, heterosexual people	Missed opportunity, indication-based: 2 years (Table 4)
Owusu et al., 2023	Europe	Systematic review; NR	Migrant women (studies, NR)	(c) migrants	Testing barriers; late diagnosis
Kitenge et al., 2023†	South Africa	Systematic review and meta-analysis; studies published 2010–2022	53 studies	Contextual: public-sector patients in a high-burden setting	AHD as defined by included studies
Jamil et al., 2021†	Multiple regions, mainly sub-Saharan Africa	Meta-analysis of RCTs published 2006–2019	General population (13 trials for uptake)	Contextual: general population	Uptake: HIV self-testing vs standard testing
Boesecke et al., 2023	Germany	Expert narrative review; earlier national data	National surveillance and cohort data	(d) older; (g) heterosexual; (c) migrants	Late diagnosis vs late presentation

AHD, advanced HIV disease; DHS, Demographic and Health Survey; EU/EEA, European Union/European Economic Area; MSM, men who have sex with men; NR, not reported in charted material; PHIA, Population-based HIV Impact Assessment; RCT, randomised controlled trial; SABSSM, South African National HIV Prevalence, Incidence, Behaviour and Communication Survey; SES, socioeconomic status. CD4 thresholds in cells/μL. Letters (a)–(g) refer to the underserved categories defined in the Methods. Data period refers to the years in which data were collected, not the year of publication. †Contextual source without a disaggregated estimate for a predefined underserved category.

Quantitative Synthesis: Determinants of Testing Uptake

Nine household-survey analyses from sub-Saharan Africa, mostly based on surveys conducted before 2021, dominated the uptake evidence (**Table 2**). Ever-testing ranged from 35.1% among men in ten countries (Ijaiya et al., 2024) to 60.5% among men in eastern Africa (Adugna & Worku, 2022) and 65.0% among adults in 13 countries, where men had about half the odds of testing of women (Sabo et al., 2024). Only 33.0% of sexually active never-married young men had recently tested, with lower odds at 15–19 years (Musonda et al., 2023), and 55.3% of young women in eastern Africa had ever tested (Worku et al., 2022). Steep gradients by education and wealth and higher testing among married people were consistent across analyses (Table 3), and in South Africa uptake was lower among men,

rural residents and less educated people in low-income households (Jooste et al., 2021). Education and marital status also explained regional variation in never-testing among Ugandan men (Jude et al., 2021). Testing thus remains concentrated among people with more resources and routine service contact, such as reproductive health care.

Lack of comprehensive HIV knowledge (Tetteh et al., 2022), discriminatory attitudes (Ijaiya et al., 2024; Sabo et al., 2024) and stigma (Alem et al., 2022) were each associated with lower testing, whereas media or internet exposure and higher-risk sexual activity were associated with higher testing. Among men who have sex with men in Semarang, Indonesia, sexual behaviour was associated with testing on personal initiative rather than on invitation by others (Sidjabat et al., 2024). Community context mattered independently: about two-thirds of the variation in men's testing was attributable to the community level, and high community rurality and illiteracy reduced testing (Ijaiya et al., 2024). Rurality was nonetheless inconsistent, being associated with higher testing in the 13-country sample (Sabo et al., 2024), which suggests that it marks service configuration rather than a fixed barrier.

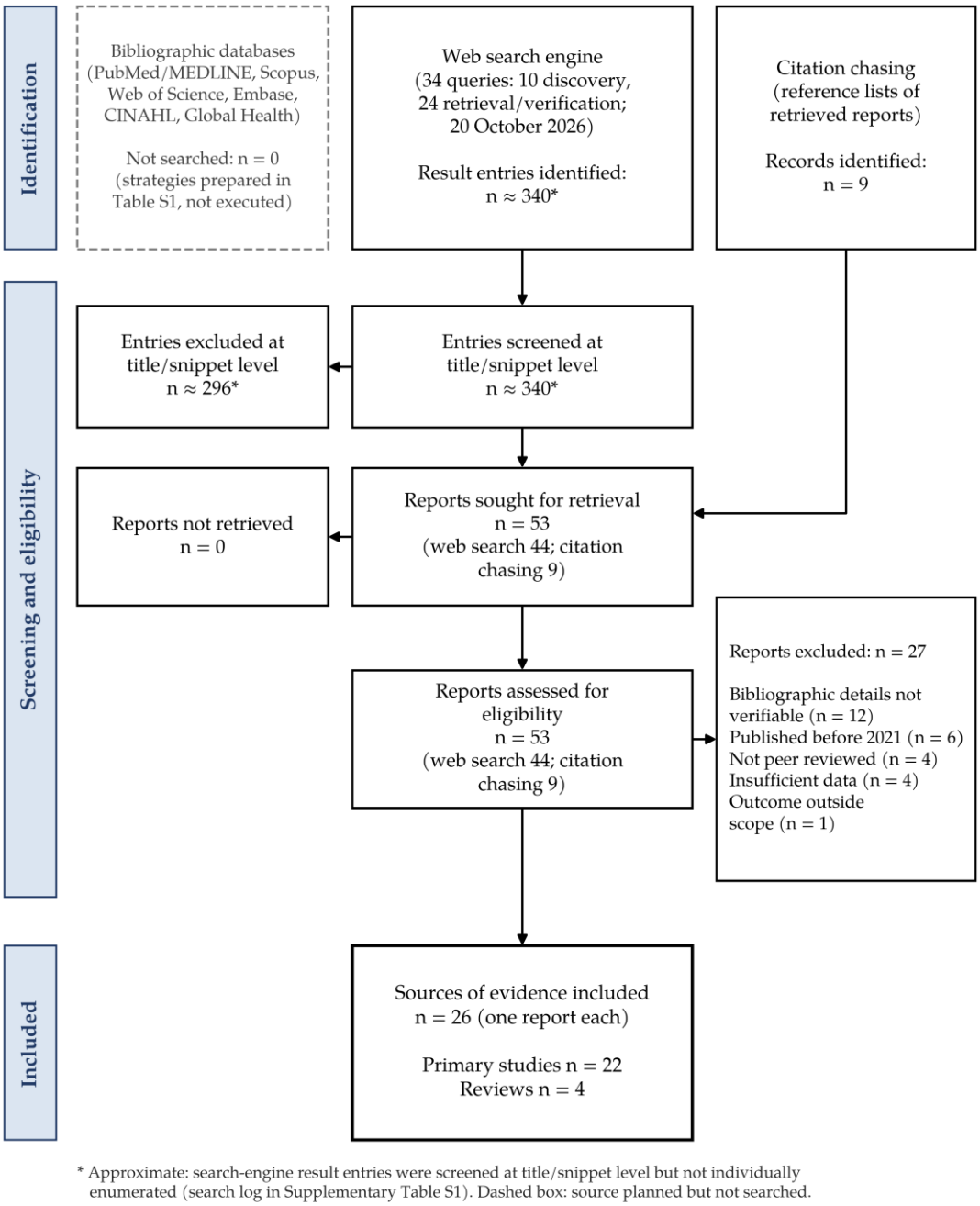


Figure 1. Flow of source identification, screening and inclusion, adapted from the PRISMA-ScR structure, showing counts from each source. Database searches were not executed; the number of search-engine entries is approximate

Health insurance was associated with higher testing among men (Adugna & Worku, 2022; Ijaiya et al., 2024). Randomised trials showed that offering HIV self-testing roughly doubled uptake across facility, partner and community distribution (Jamil et al., 2021), consistent with differentiated-testing recommendations (World Health Organization, 2024). No eligible source measured waiting times, test availability, confirmatory testing or referral directly (**Table 3**).

Table 3. Reported associations with HIV testing uptake and delayed diagnosis, by level

Level	Determinant	Outcome	Estimate as reported	Source
Individual	Higher education vs none	Uptake	↑ OR 4.40 (CrI 3.91–4.96); aOR 8.0 (7.27–8.71)	Ijaiya et al., 2024; Sabo et al., 2024
Individual	Male sex	Uptake	↓ aOR 0.51 (0.49–0.53)	Sabo et al., 2024
Individual	Age 15–19 y (never-married men)	Uptake	↓ aOR 0.59 (0.52–0.66)	Musonda et al., 2023
Individual	No comprehensive knowledge	Uptake	↓ aOR 0.59 (0.57–0.60)	Tetteh et al., 2022
Individual	Older age	Delay	↑ PR 1.84 women, 1.80 men (>50 y); aOR 1.42 per 10 y	Reyes-Urueña et al., 2025; Isosomppi et al., 2026
Individual	Sex between men vs heterosexual	Delay	↓ PR 0.74 (0.71–0.76); aOR 0.55 (0.40–0.76), urban	Reyes-Urueña et al., 2025; Isosomppi et al., 2026
Household	Married or in union	Uptake	↑ OR 2.11 (1.94–2.30); aOR 3.3 (3.16–3.46)	Ijaiya et al., 2024; Sabo et al., 2024
Household	HIV-positive partner	Delay	↑ aOR 4.65 (2.56–8.45)	Haas et al., 2022
Community	Discriminatory attitudes; stigma	Uptake	↓ OR 0.68 (0.64–0.72); aOR 0.4; aOR 0.81 (0.74–0.92)	Ijaiya et al., 2024; Sabo et al., 2024; Alem et al., 2022
Structural	Household wealth	Uptake	↑ OR 1.31 (1.17–1.47); aOR 1.50 (1.45–1.62)	Ijaiya et al., 2024; Sabo et al., 2024
Structural	Rurality	Uptake	Inconsistent: ↓ OR 0.76 (0.66–0.86); ↑ aOR 1.4 (1.28–1.45)	Ijaiya et al., 2024; Sabo et al., 2024
Structural	Rural residence	Delay	↑ aRR 1.39 (1.16–1.67); 1.14 (0.79–1.65) after area adjustment	Gibas et al., 2024
Structural	Migrant origin	Delay	↑ PR 1.27 women, 1.15 men; Asian-born women aOR 6.83 (3.49–13.35)	Reyes-Urueña et al., 2025; Isosomppi et al., 2026
Health system	Health insurance	Uptake	↑ OR 1.58 (1.45–1.73)	Ijaiya et al., 2024
Health system	Self-testing offered	Uptake	↑ RR 2.09 (1.69–2.58), 13 trials	Jamil et al., 2021
Health system	Missed opportunity	Delay	↑ AIDS-defining condition, aOR 3.23 (1.62–6.46)	Lourinho et al., 2024

↑ higher, ↓ lower likelihood of the outcome. aOR, adjusted odds ratio; aRR, adjusted risk ratio; CrI, 95% credible interval (Ijaiya et al., Bayesian model); OR, odds ratio; PR, adjusted prevalence ratio;

RR, pooled risk ratio. Other intervals are 95% confidence intervals. Associations are observational and not comparable across outcomes.

Quantitative Synthesis: Determinants of Delayed Diagnosis

Late diagnosis was common wherever measured. In 23 European countries, 49.6% of 28,521 diagnoses made in 2022–2024 were late; risk rose with age, was higher among migrants born outside the region and was lower among men who have sex with men than among heterosexual men (Reyes-Urueña et al., 2025). Late diagnosis followed pre-migration acquisition more often than post-migration acquisition (54.7% vs 21.0%). In Finland, 50.3% of diagnoses in 2008–2023 were late under the updated definition; odds rose with age and were markedly higher among Asian-born and African-born women (Isosomppi et al., 2026). In the EuResist cohort database (data 1981–2019), 50.4% were late presenters, more often older, heterosexual or African-born people (Miranda et al., 2021). In Malawi, Zambia and Zimbabwe, 49% of adults newly diagnosed in household surveys in 2015–2016 were late, with higher odds among men, older adults and people with an HIV-positive partner (Haas et al., 2022). In China, 66.6% of 22,504 diagnoses in Hunan (2018–2021) and 67.9% of 383 diagnoses in Wuhan (2023) were late, concentrated among older, male and heterosexually infected people and those referred from health facilities (Su et al., 2024; Tang et al., 2025). Advanced disease affected 43.5% of treatment-naive South Africans in studies published 2010–2022 (Kitenge et al., 2023). In Tennessee, 17.6% of 3,652 adults diagnosed in 2015–2019 received an AIDS diagnosis within 90 days; rural residence increased this risk, but the association weakened after county-level socioeconomic adjustment (Gibas et al., 2024), suggesting that rurality largely captures structural disadvantage.

These proportions should not be ranked or compared directly. They differ in threshold (CD4 below 350 or 200 cells/μL, or AIDS within 90 days), in the point of measurement (at diagnosis, at entry into care or during a household survey), in whether recent infections were reclassified, in the period of data collection and in the population (all new diagnoses, survey participants or clinic attendees). The 17.6% in Tennessee, for example, reflects a stricter AIDS-based definition rather than earlier diagnosis, and the 67.9% in Wuhan reflects a CD4 threshold applied without reclassification of recent infection.

Quantitative Synthesis: Definitions and Frequency of Missed Opportunities

Three quantitative sources examined missed opportunities, each with a different definition and observation period (**Table 4**). In New York City, a missed opportunity was any encounter within the institution at which HIV screening was not performed in the 365

days before diagnosis; 35% of 260 people diagnosed in 2018–2022 had at least one, more often older people, cisgender women and heterosexual people (Paer et al., 2023). In a Portuguese single-centre cohort (2018–2023), a missed opportunity was an encounter in the two years before diagnosis, or since the last negative test, at which national guidelines indicated testing but no test was ordered; 27.1% of 436 people had one, and it was associated with AIDS-defining conditions at diagnosis (Lourinho et al., 2024). In Finland's tax-funded system, 58% of 907 people diagnosed in 2011–2019 had a health-care contact between the estimated time of acquisition and 30 days before diagnosis; indicator conditions recorded at such contacts most commonly included pneumonia, sexually transmitted infections, fever, herpes zoster, pregnancy and lymphadenopathy (Isosomppi et al., 2025).

Table 4. Definitions, observation periods and frequency of missed opportunities in the included sources

Source	Setting; data period	Definition of missed opportunity	Type	Observation window	Frequency and main finding
Paer et al., 2023	Academic medical centre, New York City; January 2018–June 2022	Any encounter within the institution at which HIV screening was not performed	Contact-based (rationale: annual screening recommendation)	365 days before diagnosis	91 of 260 (35%) had ≥1; more frequent among older people, cisgender women and heterosexual people
Lourinho et al., 2024	Single centre, Portugal; 2018–2023	Encounter at which an HIV test was indicated by the 2014 national guideline but not ordered	Indication-based	2 years before diagnosis, or since the last negative test if more recent	27.1% of 436; associated with AIDS-defining condition at diagnosis (aOR 3.23, 1.62–6.46)
Isosomppi et al., 2025	National registers, Finland; diagnoses 2011–2019	Health-care contact before diagnosis, with ECDC indicator conditions recorded separately	Contact-based, with indicator-condition subset	From estimated acquisition (CD4-based) to >30 days before diagnosis	522 of 907 (58%) had ≥1 contact; only part involved indicator conditions
Bedert et al., 2021	Amsterdam; interviews May 2019–February 2020	Participants' accounts of encounters at which HIV was not considered	Narrative (qualitative)	Not fixed (diagnosis within the previous 5 years)	Health workers did not consider HIV despite symptoms; difficulty raising HIV with general practitioners

aOR, adjusted odds ratio (95% confidence interval); ECDC, European Centre for Disease Prevention and Control. Contact-based measures count all prior encounters and give an upper bound; indication-based measures count only encounters at which testing was indicated.

Qualitative Synthesis

Three descriptive themes emerged from the two qualitative studies and the narrative components of reviews. The first was *low perceived risk shaped by age and gender norms*. Older adults and health workers in Malaysia described the assumption that older people are not sexually active, which lowered both risk perception and acceptance of testing (Wong et al.,

2024), and people diagnosed late in Amsterdam, including men who have sex with men and migrants, described low perceived risk, the absence of symptoms and fear of the result (Bedert et al., 2021). The second was *structural and sociocultural barriers for migrants*: barriers among migrant women in Europe operated at individual (low perceived risk, stigma), sociocultural (language, gender norms) and structural levels (legal status, insurance, bureaucracy) (Owusu et al., 2023). The third was *recognition and offer within health services*: participants described difficulty raising HIV with general practitioners and health workers who did not consider HIV despite symptoms (Bedert et al., 2021), and in Germany indicator conditions less often prompted testing in women and in people other than men who have sex with men (Boesecke et al., 2023). These themes concern the opportunity-to-test stage and were not quantified in the included sources.

Comparison of Determinants Across Outcomes

Male sex, socioeconomic position and migration were shared determinants, but age operated in opposite directions: adolescents and young adults were least likely to have tested, whereas older people were most likely to be diagnosed late (Table 5). Low uptake among young people therefore reflects not having entered testing services, whereas late diagnosis among older people reflects testing that is not repeated, requested or offered as perceived risk declines, a distinct mechanism linked to missed opportunities at clinical encounters. Knowledge, stigma, media exposure, insurance and testing modality were documented mainly for uptake, whereas provider behaviour, heterosexual transmission, an HIV-positive partner and clinical referral were documented mainly for delay; these labels indicate where evidence exists rather than proof that a factor is irrelevant to the other outcome. Raising ever-tested coverage alone is therefore unlikely to reduce late diagnosis unless testing is also offered at clinical encounters and to groups perceived as low risk.

Table 5. Comparison of determinants of HIV testing uptake and delayed diagnosis

Category	Determinants	Interpretation
Shared	Male sex; low education or socioeconomic position; migration (uptake: qualitative and review evidence)	Common socioeconomic and gendered roots
Shared, opposite direction	Age: young people least tested; older people most often diagnosed late	Young people not reached by testing; older people not re-tested or offered tests as perceived risk falls
Mainly uptake	Knowledge; stigma and discriminatory attitudes; media; marital status; insurance; self-testing	Demand and access factors, mostly from household surveys
Mainly delay	Test not offered; heterosexual transmission; HIV-positive partner; referral from health facilities	Recognition and offer at clinical encounters

Category	Determinants	Interpretation
Inconsistent or insufficient	Rurality; stigma and wealth for delay; confirmatory testing; linkage	Needs area-level service data and pathway-stage outcomes

'Mainly' indicates the outcome for which evidence was found, not proof that the factor is irrelevant to the other outcome.

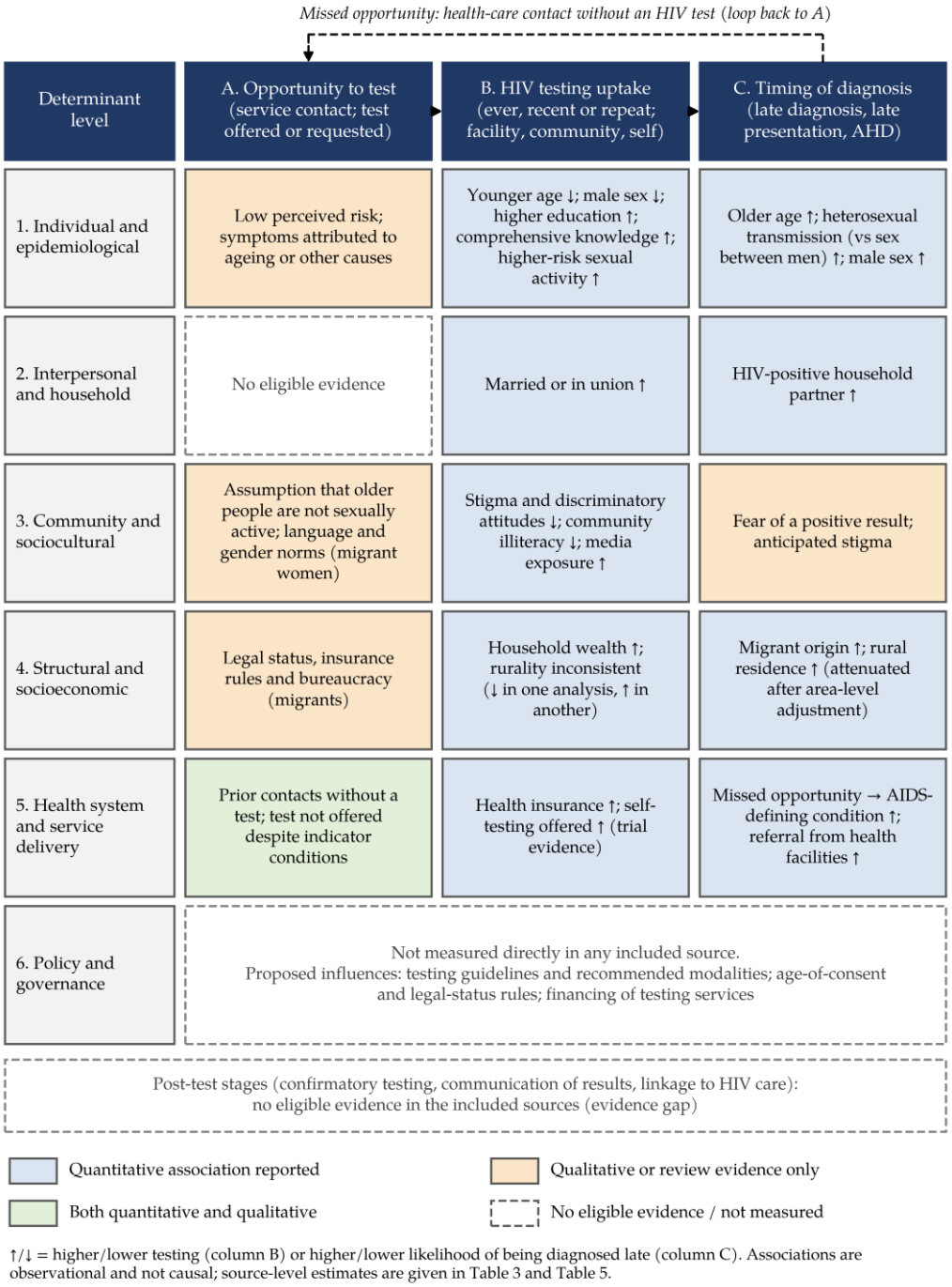


Figure 2. Multilevel conceptual framework linking determinants at six levels to the opportunity to test, testing uptake and timing of diagnosis, by type of evidence

Figure 2 organises these determinants by level and by pathway stage. Cell shading shows whether the evidence was quantitative, qualitative or both, and dashed cells mark levels or stages without eligible evidence, including policy and governance, which no source measured directly. The framework is descriptive and does not imply causality.

Interpreting Missed Opportunities: Patient Risk Perception and Provider Decisions

The missed-opportunity estimates measure different things. Contact-based measures (Paer et al., 2023; Isosomppi et al., 2025) count every previous encounter and therefore give an upper bound: some encounters were brief or unrelated, occurred soon after a negative test or took place when testing was not clinically appropriate, so not every visit should be expected to produce an HIV test. Indication-based measures (Lourinho et al., 2024) restrict the count to encounters at which a guideline or indicator condition called for testing and are closer to a true missed opportunity; in Finland, only part of the earlier contacts involved a recorded indicator condition (Isosomppi et al., 2025). No included source distinguished a test that was not offered from one that was offered and declined, so the share attributable to provider decisions rather than patient choice cannot be estimated.

Both sides plausibly contribute. On the patient side, low perceived risk, attribution of symptoms to other causes and fear of a positive result delayed requests for testing (Bedert et al., 2021; Wong et al., 2024). On the provider side, missed opportunities were more frequent among older people, women and heterosexual people (Paer et al., 2023; Lourinho et al., 2024), groups that providers may judge to be at low risk, and health workers in Malaysia described assuming that older people are not sexually active (Wong et al., 2024). When the offer of a test depends on how either party perceives risk, people who do not fit the expected risk profile are systematically missed.

These findings support two complementary approaches that do not rely on perceived risk alone: indicator-condition-guided testing, in which conditions such as sexually transmitted infections, pneumonia, herpes zoster, unexplained fever or lymphadenopathy prompt an offer of HIV testing (Isosomppi et al., 2025; Lourinho et al., 2024), and routine offering of testing to adults in defined settings, as recommended in the national guidelines cited by the source studies (Paer et al., 2023; Lourinho et al., 2024) and in WHO differentiated testing guidance (World Health Organization, 2024). Because the included evidence measured contacts and indications rather than the content of encounters, these are implications to be evaluated locally rather than demonstrated effects.

Implications, Evidence Gaps and Limitations

As implications rather than proven interventions, the evidence supports routine and indicator-condition-guided testing irrespective of perceived risk, self-testing and other private options, migrant-inclusive services, community testing where rurality and illiteracy cluster, and equity-stratified monitoring with a common definition (Supplementary Figure S2), adapted to local epidemics and capacity.

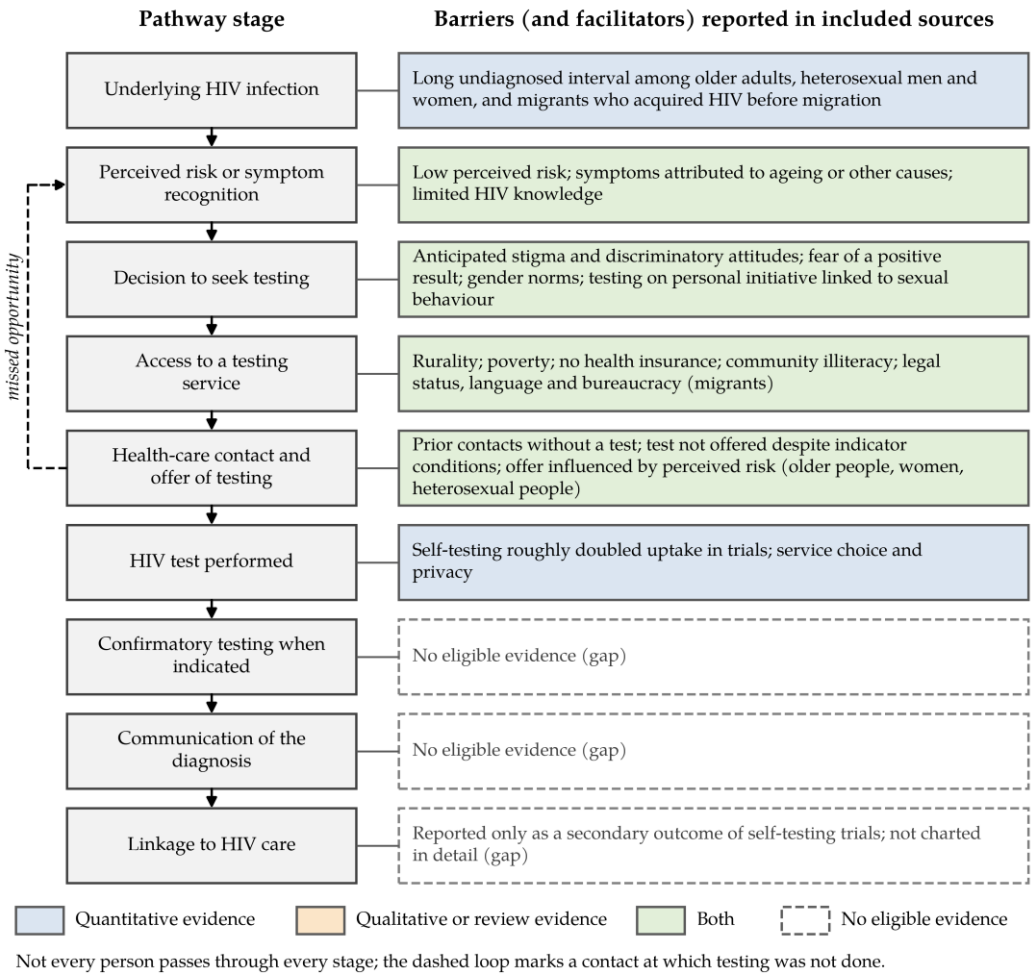


Figure 3. HIV testing and diagnostic pathway with barriers and facilitators reported in included sources and the missed-opportunity loop; not every person follows every stage

Evidence on the stages after a test was limited in the reviewed sources. No included source measured confirmatory testing or the communication of results directly, and linkage to care was reported only as a secondary outcome of self-testing trials (Jamil et al., 2021) (Figure 3; Supplementary Table S3). No eligible source addressed refugees, people experiencing homelessness, people who inject drugs, Indigenous communities or prisoners, and none came from Latin America or the Middle East; adolescents appeared only as survey age bands, without data on consent or confidentiality.

Database searches were not performed, so recall is unknown and web ranking may favour open-access sources; the number of search-engine entries is approximate because entries were not individually enumerated. Screening and charting were done by one reviewer, some data came from abstracts, only English was included, and three contextual sources did not report estimates for a predefined underserved group. The findings are a structured preliminary map requiring database-based replication with dual screening. Strengths include separation of outcome definitions and data periods, separate quantitative

and qualitative synthesis, preservation of adjusted estimates and verification of every included source.

CONCLUSIONS

Lower HIV testing uptake was associated with male sex, younger age, lower education and wealth, community illiteracy, stigma and discriminatory attitudes, whereas late diagnosis was associated with older age, migration, heterosexual transmission, rural residence and missed opportunities at clinical encounters. The two outcomes share socioeconomic roots but diverge in how age, risk perception and provider behaviour operate: young people are less often reached by testing, whereas older people and those perceived as low risk are more often diagnosed late after earlier contact with services. Delayed diagnosis is therefore partly a health-system performance problem, and testing offers guided by clinical indicators, together with routine approaches that do not depend on perceived risk alone, are warranted. Future work should replicate this map through database searches, adopt common definitions of late diagnosis and missed opportunity, measure facility-level service characteristics and post-test stages, and prioritise absent populations.

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