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Beyond the HIV Care Cascade: A Rapid Review of Patient Trajectories, Care Transitions and Multistate Modeling Approaches

Muhammad Ridwan Monisa[1], Jane Paula Jovita Hehanussa[2], Wa Ode Anabilla[2], Hana Gesti Pratiwi[2], Hana Chantika Waran[2], Damara Herlis Mailera[2], Santika Sari Rahayu Mahu[2]
[1] Master of Public Health, Universitas Indonesia Timur, Makassar, Indonesia
[2] Medical Doctor, Faculty of Medicine, Universitas Pattimura, Ambon, Indonesia

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ABSTRACT

The conventional HIV care cascade reports cross-sectional proportions and conceals repeated movement between care states. This rapid review examined how studies published from 2021 to 2026 document patient trajectories, care transitions, and multistate modeling in HIV care. Searches were run on 12 October 2026 with a general web search tool because bibliographic database counts could not be obtained; one reviewer screened 47 records, and most full texts were inaccessible, so extraction is largely abstract-level. Thirteen studies were included: six multistate analyses, one descriptive cyclical-cascade study, three group-based trajectory analyses, and three competing-risk analyses. Disengagement and re-engagement recurred across studies from Africa and North America, and loss to follow-up often conflated transfer, death, and disengagement. Younger age, depression, alcohol use, travel distance, and health-system factors were associated with transitions in individual studies. Definitions of disengagement ranged from 28 days to 18 months, which prevented pooling, and no study modeled diagnosis-to-linkage transitions. The evidence is heterogeneous and associational. Standardized state definitions, explicit handling of transfers and mortality, and complete database searching are needed.

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Corresponding Author:

Name: Muhammad Ridwan Monisa
Institution: Master of Public Health, Universitas Indonesia Timur, Makassar, Indonesia
Email: muhammadridwanmonisa606@gmail.com

1. INTRODUCTION

The HIV care continuum, often called the care cascade, describes the steps from diagnosis through linkage, retention, and antiretroviral therapy (ART) to viral suppression [1]. It underpins global program targets such as the 95-95-95 goals [2], yet in practice it is most often reported as a set of proportions at one point in time. A scoping review of statistical methods used to assess the cascade found that cross-sectional designs accounted for 93% of the articles it reviewed, and that only six of the 21 longitudinal articles used multistate models [3].

A snapshot of this kind cannot show how individuals move between states. People may interrupt treatment and return, change facility, remain engaged but unsuppressed, or die, and each of these events changes what a later cross-sectional proportion means.

Measuring retention is itself sensitive to the definition applied [4], and reviews of ART programs in sub-Saharan Africa and other low- and middle-income settings have shown that many patients recorded as lost have unknown outcomes [5]–[7]. Tracing studies found that a considerable share of such patients had died, whereas others were alive and often receiving care elsewhere [8]. Conceptual work has long moved from a cascade toward a continuum of engagement [9], and recent authors have argued for a service delivery cascade that reflects people cycling in and out of care [10].

Analytical approaches commonly used to assess cascade outcomes, such as survival analyses, have been described as failing to capture transitions into and out of care [11]. A Canadian cohort of people with HIV and hepatitis C was analyzed with multistate models because the cascade has limits in capturing the complexity of engagement patterns [12]. A population-wide analysis in the Western Cape, South Africa, showed that a cyclical cascade could be populated from routine data to capture non-linear care journeys [13].

Several statistical frameworks can represent such movement: multistate models, which estimate transitions between defined states [14]–[16]; competing-risk analyses, which treat death or transfer as events that preclude the outcome of interest [17], [18]; and group-based trajectory models, which identify latent patterns of care [19]. These approaches answer different questions, and this review keeps them separate. A study that reports several cascade stages is not, by that fact, a multistate model.

Existing syntheses address parts of this field. The scoping review cited above catalogued statistical methods using searches run between April and July 2022 [3], and a recent systematic review examined strategies to keep adolescents engaged when moving from pediatric to adult HIV services [20]. In the searches conducted for the present review, we did not identify a synthesis organized around the transitions that 2021 to 2026 studies actually model. This assessment is limited by the search scope described below and is not a claim of priority. Evidence from settings such as Indonesia illustrates the gap: a single-center study in Jakarta reported ART retention of 83.7%, 79.1%, and 77.2% in the first, second, and third years of treatment using a binary retention outcome [21].

This review therefore asks which longitudinal trajectories and care transitions have been documented and how they are defined; which statistical approaches were used; which patient-level and health-system factors are associated with transitions; what methodological limitations constrain current evidence; and what follows for program evaluation, service delivery, and research. Its contribution is a transition-oriented classification of recent studies that separates formal multistate models from descriptive, group-based, and competing-risk analyses..

2. LITERATURE REVIEW

2.1 From Cascade stages to care states

The cascade remains valuable for target setting and service monitoring, and cyclical representations have been proposed to complement it [13]. Its limitation is that a stage-wise count does not show whether people at one stage arrived directly, returned after an interruption, or came from another facility. An earlier multistate analysis in Zambia estimated the prevalence of nine care states over time since linkage, covering ART initiation, retention, transfers, and mortality, and reported that one year after loss to follow-up 51.6% of those lost before ART remained out of care compared with 30.2% of those lost after ART initiation [11]. That study was published in 2020, before the review period, and is used here only as methodological background. Policy change reinforced the shift from stages

to states: after WHO recommended ART for all people living with HIV irrespective of CD4 count [22], long-term engagement, rather than initiation alone, became a central programmatic concern, and current guidance emphasizes differentiated service delivery for people who are stable on treatment [23].

2.2 Statistical Frameworks

In a Markov multistate model the transition to a future state depends only on the current state, an assumption described in a CD4-based application in Ghana [24]. Such CD4-state models describe immunologic progression rather than movement through care and are therefore outside the care-state synthesis, although they show that the same machinery is applied to different kinds of state. Multistate models generalize survival and competing-risk analysis by allowing several transient states and recurrent moves [14], [15], [25]. Non-parametric estimation of state occupation and transition probabilities relies on the Aalen–Johansen estimator [26], software such as the msm and mstate packages for R supports panel-data and event-history applications [27], [28], flexible parametric extensions allow transition-specific distributions [29], and book-length treatments are available [30]–[32].

Competing-risk methods address the fact that a person who dies cannot subsequently be lost to follow-up; cause-specific and subdistribution approaches answer different questions [17], [33]. A study from Hawassa, Ethiopia, used Fine and Gray regression because it can reduce bias in estimating loss to follow-up when death is a competing event [34]. Group-based trajectory modeling instead assigns individuals to latent classes with similar longitudinal patterns [19], [35], which describes heterogeneity but does not define transitions between states.

2.3 Classification used in this review

Included studies were assigned to four classes: formal multistate models (explicit states with estimated transitions or state occupancy [15], [16]); descriptive state-based analyses (person-level status without a transition model); group-based trajectory models; and competing-risk analyses. A multistate model of regimen change is reported within the first class but flagged separately because its states are treatments rather than care engagement.

3. METHODS

3.1 Design, Reporting, and Registration

This study is a rapid review, a streamlined form of evidence synthesis in which some systematic-review steps are simplified to produce findings within a short time [36], [37]. It follows the structure of the PRISMA 2020 statement [38] and the search-reporting items of PRISMA-S [39], adapted to a web-based search. It was not registered in PROSPERO or any other registry. Screening and extraction were performed by one reviewer, and no independent duplicate process was carried out; single-reviewer screening is a recognized streamlining but can miss eligible records [40].

3.2 Information Sources and Search

Searches were run on 12 October 2026 using a general web search tool; 14 queries are

logged in the supplementary workbook. Query concepts combined HIV terms, care-cascade and transition terms (retention, loss to follow-up, re-engagement, treatment interruption, viral suppression, transfer), and method terms (multistate, Markov, transition probability, competing risk, group-based trajectory, longitudinal). A PubMed-style string is provided in the supplementary protocol file. Embase, Scopus, Web of Science, and CINAHL were not searched, bibliographic database record counts were not obtainable, Google Scholar was not queried directly, and reference lists were not systematically screened. General web searching is not a substitute for bibliographic databases [41], so the search should not be read as database-complete or as covering the whole of 2026.

3.3 Eligibility Criteria

Studies were eligible if they were original empirical studies of people living with HIV, published from 1 January 2021, with a longitudinal or transition component such as movement between care states, retention, treatment continuity, disengagement, re-engagement, transfer, or time-to-event outcomes between care states. Descriptive longitudinal studies, survival or competing-risk analyses, and formal multistate models were all eligible and were distinguished at synthesis. Excluded were editorials and commentaries, reviews and protocols, preprints and registry entries without full publications, studies reporting only cross-sectional cascade proportions, intervention evaluations without a transition component, duplicate reports, studies whose states were defined by CD4 count only, and records with insufficient information for extraction. Earlier landmark studies were retained only as background.

3.4 Screening, Extraction, and Appraisal

Forty-seven distinct records were logged and screened by title, abstract, or available excerpt. Full texts of most studies could not be retrieved because the repository blocked automated access, so eligibility and extraction rest mainly on abstracts and visible excerpts. A 20-field extraction sheet captured design, setting, states, definitions, methods, estimates as reported, determinants, competing events, and limitations. Estimates were transcribed as reported and not recalculated. A formal risk-of-bias assessment was not completed; design-appropriate tools were planned but not applied because full texts were unavailable, and design-level concerns are noted in the text instead. Because definitions, states, and outcome metrics differ, results were synthesized narratively by the classification in Section 2.3, and no meta-analysis was performed, in line with guidance that pooling is inappropriate when studies are too diverse [42].

4. RESULTS AND DISCUSSION

4.1 Study selection

The exploratory searches yielded 47 distinct records (Figure 1). Thirty-four were excluded: 14 were published before 2021, eight were reviews, protocols, or commentaries, four were preprints or registry entries, two evaluated interventions, two lacked a care-state transition component, two defined states by CD4 count only, and two had insufficient information. Thirteen studies were included. Because database counts were unavailable and full texts largely inaccessible, Figure 1 is adapted to a web-based search, and the included set is an illustrative rather than exhaustive sample of the 2021 to 2026 literature.

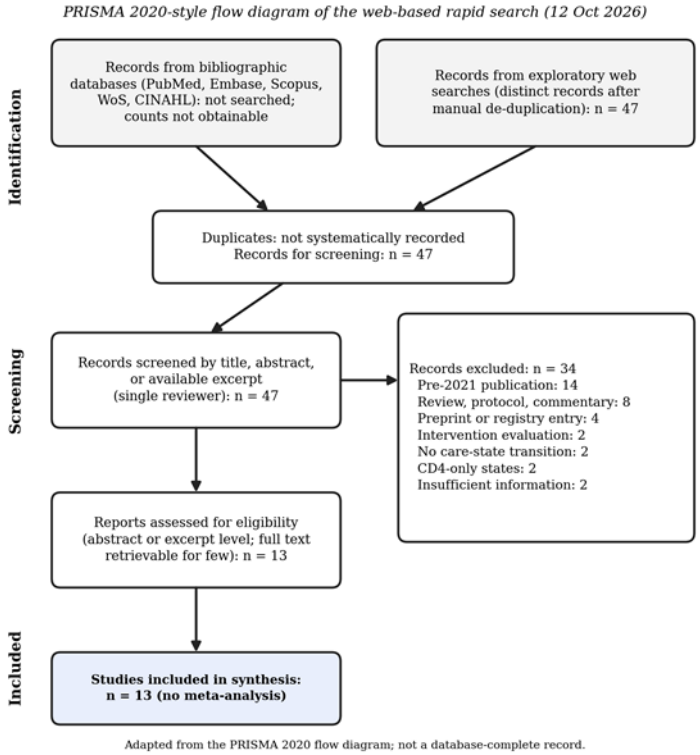


Figure 1. PRISMA 2020-style flow diagram of the web-based rapid search of 12 October 2026

4.2 Characteristics of included studies

Table 1 lists the 13 studies. Nine were conducted in sub-Saharan Africa (Ethiopia three, South Africa two, and Zambia, Cameroon, Malawi, and Nigeria one each) and four in North America (United States three, Canada one). Publication years ranged from 2022 to 2026, and where sample sizes were retrieved they ranged from 375 to 494,370 people. Most were retrospective or routine-data cohorts, and design labels were not retrieved for several. No study from Asia, Latin America, or Europe was identified in the screened set, including Indonesia. A single-center retention study from Jakarta [21] was found outside the logged search while this manuscript was being completed; it analyzed retention as a binary outcome and was not screened or included, and it will need formal assessment when the search is extended. These observations reflect the limits of the search and do not show that other studies do not exist.

Table 1. Characteristics of included studies

ID	Study	Country	Design and data source	Sample size	Period / follow-up
S1	Sikombe 2025 [43]	Zambia	Routine clinic data (design label not retrieved); 24 public HIV facilities, Lusaka	NR (full text not retrieved)	After treatment failure (duration NR)
S2	Ramakrishnan 2026 [44]	USA (Missouri)	Clinic cohort, Washington University Infectious Diseases Clinic	1,110 adults newly linked (institutional summary); n = 661 with a first disengagement episode (article)	2 years from linkage (reported)

ID	Study	Country	Design and data source	Sample size	Period / follow-up
S3	Saeed 2024 [12]	Canada	Prospective multicenter cohort (Canadian HIV-HCV Co-infection Cohort, 18 centers)	1,809 participants; 12,591 person-years	2003–2022; biannual visits to 2022
S4	Alcohol-use multistate study 2023 (CNICS) [45]	USA	Multi-site clinical cohort (CNICS; seven US clinics), ART-naive people with HIV	1,781	Enrolled 2011–2019; 102-month restricted-mean horizon
S5	Cameroon depression multistate 2025 [46]	Cameroon	Cohort entering HIV care (IeDEA Cameroon)	420; 630.1 person-years; 20% (n = 84) probable depression	2019–2020 entry; 18 months
S6	Ethiopia regimen-state multistate 2024 [47]	Ethiopia	National facility-based retrospective cohort (multi-stage clustered sampling)	NR	Oct 2019–Mar 2020 data collection
S7	Euvrard 2024 [13]	South Africa (Western Cape)	Observational cohort of routine person-level data	494,370 people who recently accessed public services	2 years before 31 Dec 2023; temporal trends over 5 years
S8	Julien 2025 [48]	South Africa (Mpumalanga)	Population-based cohort linked to clinic records (Agincourt HDSS)	NR	2015–2018
S9	Florida Ryan White 2022 [49]	USA (Florida)	Surveillance and program cohort of Ryan White clients	9,755 newly diagnosed	2010–2015
S10	Malawi perinatal 2025 [50]	Malawi (Lilongwe)	Cohort of women with HIV in antenatal care	375	Antenatal entry to 9 months postpartum (max 15 months)
S11	Ethiopia competing risks 2025 [51]	Ethiopia	Retrospective cohort	4,135 adults; 8,521.54 person-years	ART start 2019–2024 (end Apr 2024); up to 5 years
S12	Nigeria FSW 2026 [52]	Nigeria	Retrospective analysis of routine program data (female sex workers)	16,727	2016–31 Aug 2022; to 31 Aug 2022
S13	Hawassa treat-all 2024 [34]	Ethiopia (Hawassa)	Institution-based retrospective follow-up	1,190 randomly selected adults	Pre- vs post-treat-all

Source: Authors' extraction from the included studies. NR, not retrieved in the available text; FSW, female sex workers. Some publication years are inferred from record dates (see supplementary workbook). Values for S3 are from abstract-level text.

4.3 States, definitions, and transitions

Operational definitions differed widely (Table 2). Disengagement was defined as more than 60 days late for a visit in the Zambian treatment-failure study [43], a gap of 183 days or more in the Cameroonian cohort [46], no visit for 18 months in the Canadian co-

infection cohort [12], and 28 days or more after a scheduled visit or refill in an Ethiopian competing-risk study [51]. The CNICS study defined being in care as at least one visit, CD4 count, or viral load in the preceding 12 months [45]. Because one patient could be engaged under one definition and disengaged under another, estimates across these studies are not directly comparable and were not pooled. This sensitivity of retention estimates to definitions has been documented since early work on measurement [4].

Transfers were handled in four ways: as a distinct state [46]; as a competing event [51], [52]; as movement out of the cohort [12]; or merged with loss, since the CNICS study could not separate transfers from loss to care [45]. In the Western Cape study, out-of-facility mortality was incompletely observed [13]. Figure 2 summarizes the transitions that the included studies report. It is a synthesis schematic prepared for this review, not an empirically validated model. No included study modeled diagnosis-to-linkage transitions, and the Western Cape authors listed incomplete evidence of testing and linkage as a limitation [13].

Table 2. HIV care states and transition definitions across included studies

ID	States investigated	Key operational thresholds	Time scale
S1	Treatment failure; return visit; repeat VL; interruption; re-suppression; second-line switch	Interruption: >60 days late for visit	Time since failure
S2	Engaged; disengaged; reengaged; viremia	Exact thresholds NR	Time since linkage (2 y)
S3	Engaged; LTFU; reengaged; withdrawn (moved); death	LTFU: no visit for 18 months	Time since entry; biannual visits
S4	Seven states: in care/not on ART; lost before ART; dead before ART; on ART unsuppressed; on ART suppressed; lost after ART; dead after ART	In care: visit, CD4, or VL in prior 12 months; suppressed VL ≤400	Months since enrollment (102-month horizon)
S5	Linked; engaged on ART; disengaged; re-engaged; death; transfer out	Disengaged: gap of 183 days or more	Months since entry (18)
S6	Antiretroviral regimen states	Regimen change	Time to regimen change
S7	Cyclical cascade: engaged/disengaged at each step, with re-engagement	Not stated in retrieved text	Calendar window (2 years)
S8	Quarterly retention (latent trajectory groups)	Retention indicator NR	Quarters on ART, 2015–2018
S9	Care attendance per 6 months (five latent groups)	Attendance counts	Time since diagnosis
S10	At least one HIV visit attended / missed per 3-month interval	Visit attendance	Antenatal entry to 9 months postpartum
S11	LTFU; transfer out; death	LTFU: ≥28 days after scheduled visit	Time since ART start
S12	Alive in care; LTFU; death; stopped ART; transferred out	LTFU definition NR	Time since ART start (to Aug 2022)
S13	LTFU; mortality	Definition NR	Time on ART; pre/post treat-all

Source: Authors' extraction. VL, viral load; LTFU, loss to follow-up; NR, not retrieved.

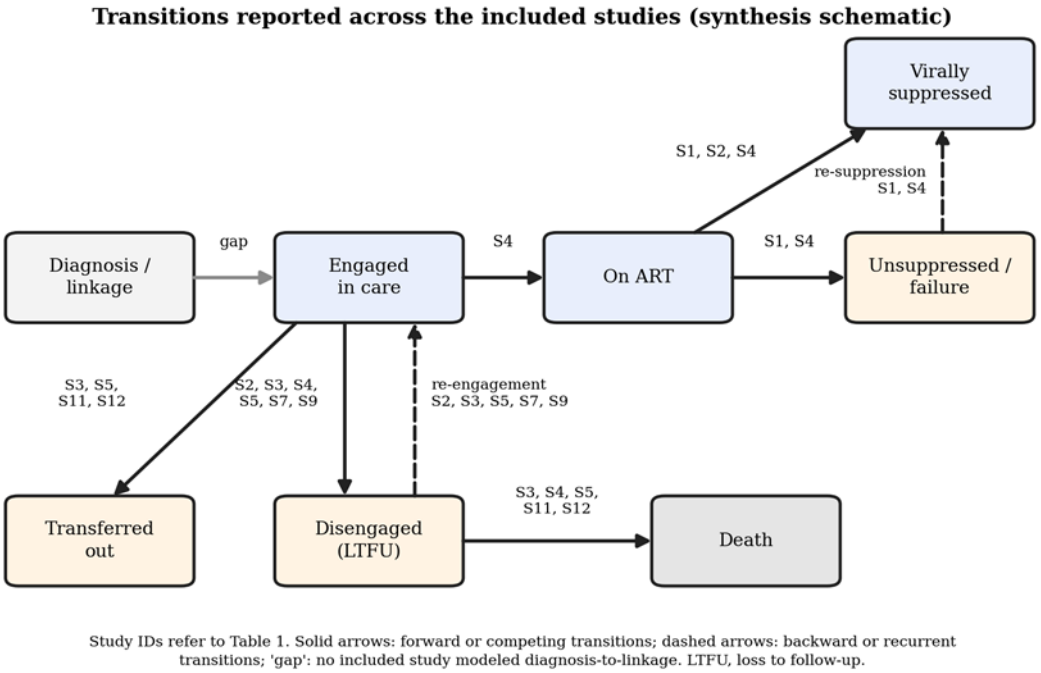


Figure 2. Transitions reported across the included studies

Source: Authors' synthesis from the state definitions in the included studies; conceptual, not an empirically validated model, and not reproduced from any published figure.

4.4 Statistical Approaches

Six studies applied multistate models (Table 3). Five modeled care-engagement states [43], [44], [12], [45], [46] and one modeled antiretroviral regimens as states [47]. These studies report state prevalence, cumulative incidence, restricted mean time in state, or prevalence differences rather than a common transition metric; the CNICS analysis, for example, reported restricted mean months over a 102-month horizon [45]. Reporting only occupancy summaries, without transition intensities, limits what such analyses can say about the speed of movement between states [15], [29]. The Western Cape study populated a cyclical cascade with person-level routine data but did not fit a transition model [13], and is classed here as descriptive and state-based.

Three studies used group-based trajectory modeling [48], [49], [50], which identifies latent groups of attendance or retention patterns. These show heterogeneity but do not estimate transitions between defined states. Three used competing-risk approaches [51], [52], [34], which treat transfer, death, or stopping ART as events that preclude loss to follow-up but do not follow people who return to care. The approaches are complementary rather than ranked (Figure 3). A multistate model is useful when recurrent movement matters, but its results depend on state definitions, on Markov or related assumptions, and on the handling of censoring and transfers. The retrieved texts did not allow us to check whether these assumptions were tested, so claims of superiority are not warranted.

Table 3. Statistical approaches for analyzing HIV care trajectories in the included studies

Approach (studies)	State structure and assumptions	Treatment of time	Competing events	Typical outputs	Strengths and limitations
Formal multistate, care states (S1–S5)	Explicit care states with backward moves (re-engagement); death as absorbing state; Markov or state-occupancy assumptions, testing NR	Continuous time since index event (linkage, enrollment, failure)	Death and transfer as states (S3, S4, S5)	State prevalence; cumulative incidence; restricted mean months; prevalence differences	Shows recurrent movement; results depend on state definitions; S4 merges loss with transfer; S5 small sample
Multistate, regimen states (S6)	Regimens as states; msm Markov survival model	Time to regimen change	NR	Time to treatment modification; risk factors	Treatment continuity, not engagement; details NR
Descriptive state-based (S7)	Cyclical cascade statuses; no transition model	Calendar time; 2-year window	Out-of-facility death incompletely seen	Counts and proportions by status	Scalable with routine data; no transition intensities
Group-based trajectory (S8–S10)	Latent groups of retention or attendance; multinomial regression for membership	Quarters, 3- or 6-month intervals	Not modeled	Group shares; relative risk or odds ratios	Reveals heterogeneity; no state-transition structure; depends on attendance definition
Competing risk (S11–S13)	One event of interest with competing death, transfer, stopping ART	Time since ART start	Explicit (Gray, Fine–Gray)	Cumulative incidence; rates per 100 person-years	Avoids overestimating LTFU; single event; return to care not followed

Source: Authors' synthesis of the included studies. S-codes refer to Table 1. NR, not retrieved; LTFU, loss to follow-up.

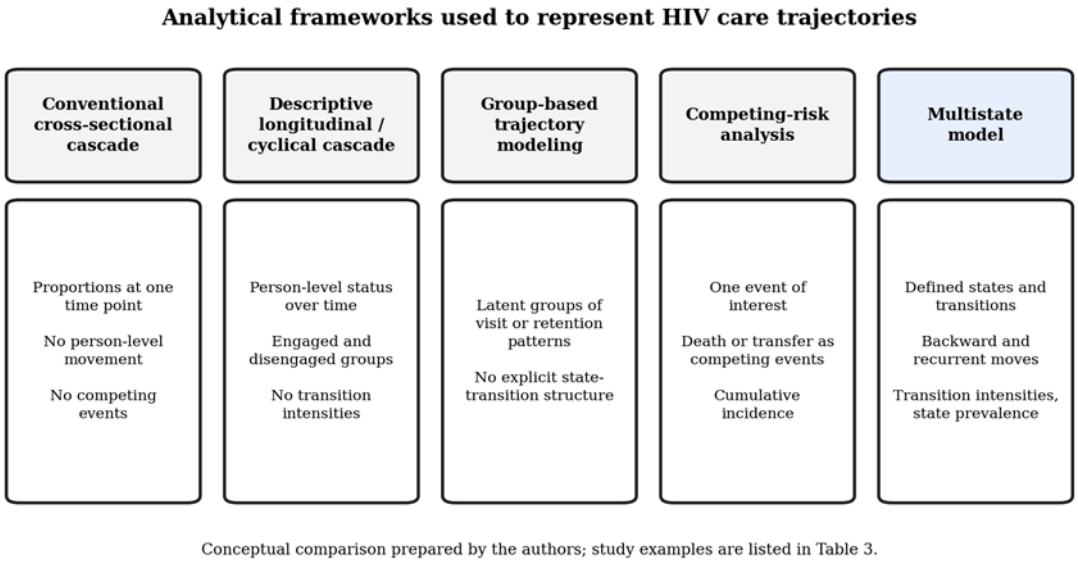


Figure 3. Analytical frameworks used to represent HIV care trajectories

Source: Authors' conceptual comparison; not an empirical model and not reproduced from a published figure.

4.5 Determinants of transitions and continuity

Table 4 summarizes factors reported in the included studies. Younger age recurs: it was associated with disengagement, reengagement, and viremia in Missouri [44], with suboptimal engagement trajectories in Florida [49], and with membership of a lower visit-attendance group in Lilongwe (odds ratio 3.82, 95% CI 1.25 to 11.73 for age under 25 years) [50]. In rural South Africa, consistently high retention was more likely among women and people aged 40 years or older [48]. Heightened depressive symptoms at enrollment were associated with lower continuous engagement at month 18 in Cameroon (prevalence difference −14.3, 95% CI −27.0 to −2.3) [46]. In the CNICS cohort, unhealthy alcohol use at enrollment was associated with more time lost to clinic after ART initiation in the unadjusted analysis, but the adjusted difference was imprecise (+4.3 months, 95% CI −0.2 to 9.7), and alcohol use was not associated with time spent virally suppressed [45]. In Canadian co-infected adults, detectable HCV RNA, incomplete HCV treatment, and recent incarceration were associated with loss to follow-up [12]. In the Ethiopian regimen-state model, tuberculosis, low CD4 count, opportunistic disease, and low body weight were associated with regimen change [47]. Travel time above one hour was associated with lower attendance probability in Lilongwe (odds ratio 3.54, 95% CI 1.44 to 8.69) [50].

Health-system and policy context also appeared. Loss to follow-up incidence was reported as higher after treat-all implementation in Hawassa (8.67 versus 4.92 per 100 person-years) [34], a policy that WHO recommended in 2015 [22], and the Zambian study identified delays in returning for adherence counseling and missed opportunities to recheck viral load or switch regimen after treatment failure [43]. Stigma, insurance, financial barriers, social support, and facility fragmentation were not reported in the retrieved text of the included studies, so no statement is made about them. These findings are associations from observational data, with different adjustment sets and outcome definitions, and none supports a causal interpretation.

Table 4. Determinants of transitions and care continuity reported in the included studies

Domain	Factor	Transition or outcome	Study	Reported estimate and direction
Age	Younger age	Disengagement, reengagement, viremia	Ramakrishnan 2026 [44]	Estimate not retrieved; higher likelihood
Age	Younger age	Suboptimal engagement trajectories	Florida 2022 [49]	Estimate not retrieved; more likely
Age	Age <25 years	Lower visit-attendance group (perinatal)	Malawi 2025 [50]	OR 3.82 (1.25–11.73); higher odds
Age and sex	Female; age 40 years or older	Consistently high retention	Julien 2025 [48]	Estimate not retrieved; more likely
Race and ethnicity	Black race; Indigenous; Hispanic/Latino	Disengagement and viremia; mortality; frequent care	[44]; [12]; [49]	Estimates not retrieved; direction as stated
Mental health	Heightened depressive symptoms	Continuous engagement at month 18	Cameroon 2025 [46]	PD −14.3 (−27.0 to −2.3); lower engagement
Substance use	Moderate or unhealthy alcohol use	Retention; time lost to clinic after ART	CNICS 2023 [45]	Unhealthy vs none: +7.6 months (3.1–11.7), unadjusted; adjusted +4.3 (−0.2 to 9.7)

Domain	Factor	Transition or outcome	Study	Reported estimate and direction
Co-infection, justice	Detectable HCV RNA; incomplete HCV treatment; recent incarceration	LTFU	Saeed 2024 [12]	Estimates not retrieved; associated with LTFU
Clinical	TB, low CD4, opportunistic disease, low body weight	Regimen change	Ethiopia 2024 [47]	Estimates not retrieved; risk factors
Structural	Travel time >1 hour	Lower visit-attendance group	Malawi 2025 [50]	OR 3.54 (1.44–8.69); higher odds
Health system and policy	Treat-all era; viral-load monitoring and switching; COVID-19 enrollment era	LTFU, mortality; post-failure care; attendance	[34]; [43]; [50]	LTFU 8.67 vs 4.92 per 100 PY post vs pre treat-all; delays reported; OR 0.23 (0.07–0.74) after COVID-19 onset

Source: Authors' extraction. OR, odds ratio; PD, prevalence difference; PY, person-years; LTFU, loss to follow-up. Estimates are reported unadjusted or adjusted as in each study and are not harmonized. No included study reported stigma, insurance, financial barriers, or social support in the retrieved text.

4.6 Pathway evidence by transition

Table 5 links each major transition to the studies that report it. For the in-care to disengaged transition, the Missouri cohort estimated that 39.7% (95% CI 36.4 to 43.0) were disengaged from clinic two years after linkage, and that the cumulative incidence of ever disengaging was 66.2% [44]. In the Canadian cohort, 46% had at least one episode of loss to follow-up and 57% of these re-engaged [12]. These figures come from abstract-level text and differ in definitions, so they illustrate recurrence rather than allow comparison.

Transfer and death were reported as competing outcomes. In an Ethiopian cohort the cumulative incidence of transfer out was about 7%, 15%, and 25% at one, three, and five years, alongside loss to follow-up of about 15%, 25%, and 35% [51]. Among female sex workers in Nigeria, 3% transferred out and under 1% died during follow-up to August 2022 [52]. For viral suppression, the CNICS study estimated unadjusted restricted mean time in care and suppressed of 62.3 months among people with no alcohol use and 59.5 months among those with unhealthy use over 102 months, with overlapping confidence intervals [45], and the Zambian study documented delays in the steps between treatment failure and re-suppression or regimen switch [43].

Several transitions had no direct support. No included study modeled diagnosis to linkage, inpatient to outpatient care, or continuity-preserving transfer between facilities as a measured transition. Adolescent transition from pediatric to adult services was addressed only in a separate systematic review, which reported that retention often declined to about 70% by two years after transition [20]; that review was not part of the evidence base for pooled interpretation. Perinatal engagement was examined in one trajectory study [50]. These are evidence gaps within this search, not demonstrations that the transitions are unstudied.

Table 5. Pathway evidence: transitions, definitions, methods, and reported outcomes

Transition	Studies	Operational definition	Method	Reported outcome	Implication or gap
In care to disengaged	S2, S3, S4, S5, S7	LTFU gap 183 days to 18 months, or no visit/CD4/VL in 12 months	Multistate; descriptive	S2: 39.7% disengaged and 66.2% ever disengaged at 2 y [44]; S3: 46% with ≥1 LTFU episode	Target sustained engagement, not isolated missed visits

Transition	Studies	Operational definition	Method	Reported outcome	Implication or gap
Disengaged to re-engaged	S2, S3, S5, S7, S9	Return after gap; re-engage group	Multistate; GBTM	S3: 57% re-engaged; S5: re-engagement at 6 months PD −10.2% (−25.7 to 5.9) with depression	Track re-engagement as an outcome
Engaged to transfer out	S5, S11, S12	Documented transfer; state or competing event	Multistate; competing risk	S11: about 7/15/25% at 1/3/5 y; S12: 3%	Link records across facilities
Any state to death	S3, S4, S5, S11, S12	Recorded death	Multistate; competing risk	S3: 383 (21%) died; S12: <1%; S11: about 5% at 1 y	Report mortality after LTFU explicitly
Linkage to ART initiation	S4	In care, ART not initiated, to on ART	Multistate (RMT)	S4: mean 5.1 (4.3–5.9) months in care not on ART with no alcohol use vs 6.6 (5.6–7.8) with unhealthy use (unadjusted)	Diagnosis-to-linkage not modeled (gap)
Unsuppressed to suppressed	S1, S2, S4	Re-suppression after failure; VL ≤400	Multistate	S4: 62.3 vs 59.5 months suppressed (unadjusted; overlapping CIs); S1: delays after failure [43]; S2: viremia during disengagement	Strengthen VL monitoring after failure
Regimen switch	S1, S6	Switch to second-line; regimen change	Multistate	S1: missed switching opportunities; S6: determinants listed	Treatment continuity outcomes
Perinatal engagement	S10	Visit attended or missed per 3 months	GBTM	Lower-attendance group 7%; age <25 and travel >1 h associated	Perinatal-specific multistate work needed
Diagnosis to linkage; inpatient to outpatient; inter-facility continuity; adolescent transfer	None included	Not available	Not available	Adolescent review only [20]	Evidence gap in this search

Source: Authors' synthesis; estimates as reported in included studies, abstract-level for several. RMT, restricted mean time; GBTM, group-based trajectory modeling; LTFU, loss to follow-up; VL, viral load; PD, prevalence difference.

4.7 Methodological limitations of the evidence

Four limitations stand out. First, state definitions are heterogeneous, with disengagement thresholds ranging from 28 days to 18 months, so that the same patient may be classified differently across studies. Second, loss to follow-up conflates true disengagement with undocumented transfer and death; the CNICS study could not separate loss from transfer [45], and in the Western Cape study out-of-facility mortality was incompletely observed [13]. Third, competing events were handled inconsistently, being modeled as states, as competing events, or not described in the retrieved text. Fourth, several analyses used selected or single-site populations, such as a single clinic in Missouri [44], a co-infected cohort in Canada [12], and female sex workers in Nigeria [52], which limits generalizability. Transition-specific hazard ratios, model assumptions, and missing-data handling could not be extracted from the available text. Table 6 links these limitations to research priorities.

Table 6. Methodological gaps and future research priorities

Gap	Evidence basis in included studies	Research priority
Heterogeneous state definitions	Disengagement from 28 days to 18 months (S1, S3, S5, S11)	Harmonized definitions with sensitivity analyses across thresholds
Transfer and LTFU conflated	S4 merged loss and transfer; S7 lacked out-of-facility death data	Cross-facility record linkage; tracing samples to separate transfer, death, and disengagement
Competing events inconsistently handled	States in S3–S5; competing events in S11–S13; not described elsewhere	Report competing events explicitly; use cumulative incidence or multistate estimation
Entry and system transitions rarely modeled	No included study on diagnosis-to-linkage, inpatient-outpatient, or inter-facility continuity	Include entry and facility states in models and data design
Assumptions and missing data not retrievable	Markov and homogeneity assumptions not checked in retrieved texts	Report and test assumptions; share code and analysis plans
Geographic and method coverage	No Southeast Asian study in the screened set (one Indonesian binary-outcome retention study was found outside it); no hidden Markov, semi-Markov, or joint models identified	Targeted searches and applications, including Indonesia
Review completeness	Single reviewer, no database counts, abstract-level extraction	Database searching, duplicate screening, full-text verification, and formal risk-of-bias appraisal

Source: Authors' synthesis. LTFU, loss to follow-up.

4.8 Implications for HIV programs, service delivery, and research

For program evaluation, the Missouri authors concluded that retention efforts should shift from preventing isolated missed visits toward supporting sustained engagement [44]. The Western Cape analysis suggests that cyclical cascades can be populated from routine data and complement the traditional cascade [13]. The Zambian findings indicate that routine care after treatment failure may leave gaps in viral-load rechecking and regimen switching that programs can monitor directly [43]. For service delivery, the associations with young age, perinatal status, travel distance, depression, and alcohol use identify groups and screening opportunities worth testing in intervention studies, but these are associations and do not show that addressing them improves transitions. Because differentiated service delivery presupposes knowing who needs more or less support over time [23], transition-based monitoring could inform that targeting, although this remains an inference rather than a finding of the included studies. For research, priorities are in Table 6: shared state definitions, linkage across facilities, explicit handling of competing events, and extension to settings not yet represented, including Indonesia and Southeast Asia.

4.9 Strengths and limitations of this review

Strengths include a transparent search and screening log, a pre-specified classification that separates formal multistate models from descriptive and other approaches, and the avoidance of invented estimates. The limitations are substantial. The search used a general web tool rather than bibliographic databases, so relevant studies are likely missing and database counts are unavailable. Screening and extraction were done by one reviewer, mostly on abstracts and excerpts, and several estimates were taken from abstract-level or secondary text and

must be checked against full papers. Formal risk-of-bias appraisal was not completed. Publication years and bibliographic details for several included studies remain incomplete (see the supplementary verification table). The included set is therefore illustrative, and the numbers may change when screening is completed.

5. CONCLUSION

This rapid review of 13 studies published from 2022 to 2026 shows that HIV care is often non-linear: disengagement, re-engagement, transfer, and death recur, and a conventional cascade does not display them. Formal multistate models, competing-risk analyses, and group-based trajectory models each describe part of this movement, but state definitions and the handling of transfer and death vary too much for results to be compared or pooled. Younger age, depression, alcohol use, travel distance, and health-system factors were associated with transitions in individual studies, but the evidence is associational and incomplete, and no included study modeled diagnosis-to-linkage or inter-facility transitions.

We suggest that future studies adopt harmonized state definitions with sensitivity analyses across thresholds, link records across facilities to separate transfer from disengagement, report competing events and model assumptions explicitly, and extend this work to settings not yet represented, including Indonesia and Southeast Asia. This review should be completed with database searches, duplicate screening, and full-text verification before its conclusions are relied on.

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BIOGRAPHIES OF AUTHORS

	Muhammad Ridwan Monisa, S.Ked., M.Kes. Muhammad Ridwan Monisa completed his undergraduate medical education at Universitas Pattimura and earned a Master of Health degree from Universitas Indonesia Timur, Indonesia. His research interests include HIV/AIDS, delayed HIV diagnosis, health-related stigma, early disease detection, and health services research, particularly in remote and underserved communities. ORCID: https://orcid.org/0009-0003-9789-461X Email: muhammadridwanmonisa606@gmail.com
	Jane Paula Jovita Hehanussa, S.Ked. Jane Paula Jovita Hehanussa completed her undergraduate medical education at Universitas Pattimura, Indonesia. Her research interests include HIV/AIDS, delayed HIV diagnosis, health-related stigma, early disease detection, and health services research, particularly in remote and underserved communities. Email: janejovitahehanussa@gmail.com
	Wa Ode Anabilla, S.Ked. Wa Ode Anabilla completed her undergraduate medical education at Universitas Pattimura, Ambon, Indonesia. She has conducted research on burnout among medical students and is currently interested in expanding her research experience into other areas of health research. ORCID: https://orcid.org/0009-0004-4235-2036 Email: abilawd@gmail.com



dr. Hana Gesti Pratiwi, S.Ked.
Hana Gesti Pratiwi completed her undergraduate medical education and professional medical training at Universitas Pattimura, Indonesia. Her research interests include infectious diseases, public health, dermatology, early disease detection, and health services research, particularly in efforts to improve the quality of healthcare services and community health outcomes.
Email: hanapratiwi1109@gmail.com



Hana Chantika Waran, S.Ked.
Hana Chantika Waran earned her undergraduate medical degree from Universitas Pattimura, Indonesia. Her research focuses on HIV/AIDS prevention, sexual and reproductive health, and expanding access to HIV-related health services. She also studies anemia among adolescent girls and the prevention of stunting through early intervention across the life course. She is particularly interested in strengthening the health and nutritional status of adolescent girls before pregnancy, with a special emphasis on remote and underserved communities.
Email: hanawrn20@gmail.com