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Community-based HIV Case Detection Among Biological Children of HIV-positive Index cases in Ethiopia: Outcomes and Key Predictors

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Abstract

Background: Early detection of HIV among children remains suboptimal in high burden settings. Community based pediatric index case testing is a voluntary and confidential and safe approach that may improve early identification of undiagnosed HIV positive children and ensures timely linkage to pediatric HIV care and treatment service. This study assessed the outcomes of community based pediatric index case testing and identified predictors of HIV positivity among biological children of HIV positive index cases in Ethiopia.

Methods: A retrospective cross-sectional study was conducted using routine program data collected between October 2021 and October 2025. A total of 46,717 biological children aged 1.6–14 years were tested for HIV through community-based index case testing across 306 health facilities in nine PEPFAR supported regions. Data were collected using the CommCare mobile application and analyzed using SPSS version 20. Multivariable logistic regression was used to identify predictors of HIV positivity.

Results: Overall, 563 children were newly diagnosed with HIV (positivity rate: 1.2%; 95% CI: 0.79–1.61). Positivity was highest among children aged 1.6–<3 years (5.6%) and increased within this group when index cases were aged 18–24 years or newly diagnosed, reaching 16.5% and 14.9%, respectively. Whereas children if Index clients enrolled in community care and support or clinically stable had lowest (0.7%) positive yield.

Younger children aged 1.6 to <3 years (AOR = 5.51; 95% CI: 4.26–7.14), having a younger index case aged 18–24 years (AOR = 2.97; 95% CI: 2.08–4.22), residence in Oromia (AOR = 2.11; 95% CI: 1.54–2.89) or Amhara regions (AOR = 1.91; 95% CI: 1.39–2.64), being newly diagnosed index case (AOR = 3.90; 95% CI: 2.76–5.51), and experiencing multiple adherence challenges (AOR = 3.48; 95% CI: 1.99–6.38) were independently associated with HIV positivity among children.

Conclusions: Community based pediatric index testing effectively identifies previously undiagnosed HIV positive children who are often missed by traditional facility-based testing approaches. This strategy complements facility-based services and scaling it up can significantly strengthen pediatric HIV case detection in high burden settings

1. Introduction

Pediatric HIV case identification remains substantially lower than that observed among adults in many high-burden settings, including Ethiopia [1–4]. Globally, an estimated 63% of children under 15 years living with HIV are aware of their HIV status, compared with significantly higher coverage among adults [5]. Despite the availability of free antiretroviral therapy (ART) and prevention of mother-to-child transmission (PMTCT) services, a considerable proportion of children living with HIV remain undiagnosed [1–4]. Delayed diagnosis is associated with advanced disease at presentation, increased morbidity and mortality, and delayed treatment initiation [6–7].

Sub-Saharan Africa bears the largest burden of pediatric HIV, with approximately 66% of children living with HIV aware of their status [5]. This regional gap is reflected in Ethiopia, where pediatric HIV case detection remains below national and global targets. Current estimates indicate that only about 52% of children living with HIV in Ethiopia know their HIV status, falling short of the UNAIDS 95–95–95 targets [8]. This gap persists despite expanded PMTCT coverage and routine facility-based HIV testing services [1–4].

Evidence from Ethiopia further indicates that mother-to-child transmission (MTCT) remains above the elimination threshold of less than 5% in several settings [9–13]. A pooled analysis conducted after the introduction of PMTCT programs reported an overall MTCT rate of approximately 4.1%, with higher rates documented in specific regions such as West Shewa (9.7%) and South Omo Zone (5.3%) [9–10]. These findings highlight persistent gaps in early infant diagnosis, postnatal testing, and continuity of care [12–13], resulting in missed opportunities to identify HIV-positive children through routine facility-based services [14–15].

More than 95% of HIV infections among children aged 0–14 years occur through vertical transmission [16]. However, HIV-exposed infants and children are not consistently tested throughout breastfeeding and early childhood [14–15 Missed testing opportunities are frequently driven by loss to follow-up along the PMTCT cascade, limited caregiver awareness, HIV-related stigma, and structural barriers to facility-based care [17–19]. Consequently, many children are only diagnosed after the onset of clinical symptoms, reducing the benefits of early treatment initiation [6–7].

Index case contact testing has been shown to be a high-yield strategy for identifying previously undiagnosed people living with HIV, including children [16, 20]. This approach involves eliciting and offering HIV testing to biological children and sexual partners of individuals with known HIV infection. Pediatric index case testing is particularly relevant in high-burden settings, where undiagnosed infections are often clustered within affected households [21]. Accordingly, national and international guidelines recommend routine HIV testing for all biological children of index cases [17, 21].

Despite these recommendations, implementation of pediatric index case testing remains constrained by individual, family, and health system-level barriers [17]. These include caregiver concerns about stigma and disclosure, fear of potential social harms such as intimate partner violence, reluctance to consent for pediatric testing, and limited health care worker capacity to deliver child-focused HIV services [18, 19]. When testing is limited to facility-based models, these barriers may further reduce uptake among eligible children [18, 22].

To address these challenges, community-based index case testing approaches have been introduced to complement facility-based services [19, 22]. These approaches aim to reduce access barriers by bringing testing services closer to households and offering flexible, client-centered delivery options. They are particularly important for children and families with limited engagement in the formal health system, including those lost to follow-up from PMTCT and ART programs [16, 23].

In Ethiopia, the PEPFAR/Department of State-supported Community HIV Care and Treatment (CHCT) activity introduced a community-based index case contact testing model targeting underserved

populations. Trained community health workers (Community Engagement Facilitators, CEFs) collaborated with health facilities and implementing partners to identify and test biological children aged 1.6 to 14 years with unknown HIV status.

Under this model, eligible children identified through index elicitation are offered voluntary HIV testing in community settings, with attention to confidentiality, caregiver counseling, and child-appropriate service delivery. Children diagnosed with HIV are actively linked to nearby health facilities for ART initiation and ongoing care. This approach aims to improve early diagnosis and linkage to treatment among children [23].

Despite its potential, community-based pediatric index case testing in Ethiopia has been implemented in limited settings, and its outcomes have not been comprehensively evaluated. Evidence on testing uptake, positivity yield, and predictors of HIV positivity among biological children in community-based index case testing programs remains scarce. Therefore, this study aimed to assess the outcomes of community-based pediatric index case testing and identify predictors of HIV positivity among biological children of index cases in Ethiopia.

2. Methods

2.1. **Study Area and Setting**

This implementation research was conducted across nine PEPFAR supported regions including Addis Ababa, Amhara, Oromia, Gambella, Tigray, and the former Southern Nations, Nationalities, and Peoples' Region (SNNPR), which has been reorganized into Sidama, Southwest Ethiopia, Central Ethiopia, and South Ethiopia regions. The community-based intervention was implemented in collaboration with 306 health facilities across these regions.

The Community HIV Care and Treatment (CHCT) activity was a PEPFAR funded initiative implemented by Project HOPE Ethiopia in collaboration with the Ministry of Health and local partners. Since 2017, CHCT had aimed to accelerate and sustain HIV epidemic control in Ethiopia through community-based HIV care and treatment services.

To enhance pediatric HIV case detection and early HIV treatment initiation, the CHCT program introduced community-based HIV testing to biological children of index cases. Trained Community Engagement Facilitators (CEFs) received lists of HIV positive index cases from nearby health facilities, particularly those clients who were unable to bring their biological children to health facilities, as well as from CHCT service delivery and other community platforms, including associations of people living with HIV, while ensuring confidentiality and data security. The CEFs located HIV positive index cases and provided counseling to support elicitation of biological children with unknown HIV status. Index cases who accepted the offer had their biological children provided with community-based HIV testing services. The CEFs performed conventional HIV testing at the community level, and children newly identified as HIV positive were linked to HIV care and treatment services.

2.2. **Study Design**

A quantitative retrospective cross-sectional study was conducted using index case testing records collected between October 2021 and October 2025. The study included 46,717 biological children aged 1.6–14 years who were identified through index cases across 306 health facilities in nine high burden regions of Ethiopia.

2.3. **Source Population and Study Population**

The source population comprised biological children with unknown HIV status who were elicited by index cases aged 18 years and above between October 2021 and October 2025.

The study population included all biological children aged 1.6–14 years who received community-based HIV testing services and had their HIV test results clearly documented in community-based source documents and the Unified Data System (UDS). Children under 18 months of age, for whom test results were not documented, and children tested through community level HIV self-testing modalities were excluded from the study.

2.4. **Sample Size / Participants**

A total of 46,717 biological children aged 1.6–14 years who underwent HIV testing through community-based conventional testing modalities and had documented test results in the UDS during the study period were included in the analysis. All eligible children tested through the program during the study period were included.

2.5. **Data Collection Procedures**

Project HOPE developed a standardized UDS built on the CommCare platform. The UDS was a digital health application designed for data entry on mobile devices. Trained CEFs assigned to specific community-based service delivery units collected individual child level data using dedicated user accounts and entered the data into the CommCare application based on information recorded in community testing registers. Data were stored on the UDS local server for analysis.

2.6. **Data Quality Control**

Data quality was ensured through built in validation rules incorporated into the UDS at the design stage. User access to the system was granted based on assigned roles. Additional measures included comprehensive training of data collectors, use of standardized user manuals, regular data quality assessments, and continuous supportive supervision. Data cleaning and verification were conducted quarterly by implementing partners and the digital health team. These measures helped maintain data accuracy, completeness, and consistency throughout program implementation and the study period.

2.7. **Data Processing and Analysis**

Data was identified and exported from the UDS system to Microsoft Excel and SPSS version 20 for statistical analysis. Descriptive statistics were used to summarize key variables using frequencies, percentages, tables, and charts. Bivariate logistic regression analyses were conducted to identify potential

predictors at a p value threshold of < 0.20, which were subsequently included in multivariate binary logistic regression models to control for confounding variables. Statistical significance was set at $p < 0.05$, and results were reported as adjusted odds ratios (AORs) with 95% confidence intervals (CIs). Model fitness was assessed using the Omnibus test ($p < 0.001$) and the Hosmer–Lemeshow goodness of fit test ($p = 0.72$), indicating that the model was well fitted.

2.8. **Study Variables**

The primary outcome variable was biological children's HIV test result, measured as a binary outcome. Participants were classified as HIV positive or HIV negative based on their community-based HIV testing results.

Independent variables were categorized into four domains. Sociodemographic factors included the child's age and sex, the index case's age and sex, place of residence, source of index recruitment, and service delivery location. Clinical and adherence related factors included clinical stability, history of treatment interruption, current viral load status, and whether the index case was newly diagnosed with HIV. Service-related factors comprised the year the child was tested, the number of children elicited per index case, and the results of intimate partner screening, and community support of index cases through community-based HIV case management services related factors were included.

2.9. **Operational Definition**

Index case: A mother or father living with HIV who was contacted by CEFs to identify biological children with unknown HIV status for HIV testing.

Biological children: Children born to the index case (mother or father) who were genetically related to them.

Pediatric index case testing: HIV testing to biological children of a known HIV positive adult (the index case), targeting children aged from 1.6 to 14 years who may not be reached through routine facility-based HIV testing.

Hospital: A hospital is a secondary or tertiary health facility that provides specialized and advanced medical services, including inpatient care, advanced diagnostics, and surgical services. Hospitals serve as referral centers for cases beyond the capacity of health centers.

Health Center: A health center is a primary-level public health facility that provides preventive, promotive, and basic curative services to a defined catchment population. It serves as the first referral level from health posts and refers complicated cases to hospitals.

2.10 Ethical Considerations

Ethical approval was obtained from the Ethiopian Public Health Association Institutional Review Board (Reference No. EPHA/OG/859/25) to allow analysis of the program data for this study. The approval covered the retrospective analysis of routinely collected program data. During routine service delivery, informed consent was obtained from parents or legal guardians, and assent was obtained from pediatric

participants as appropriate. For this study, all data were de-identified prior to analysis and no personal identifiers were included. Confidentiality of participants was strictly maintained. The study was conducted in accordance with the principles of the Declaration of Helsinki and relevant national guidelines.

3. Results

3.1 Sociodemographic Characteristics of Index Cases and Their Biological Children

A total of 29,293 HIV-positive index cases aged ≥18 years were included, of whom 71% were female. Most index cases were identified through community platforms (66%), followed by health facilities (18%) and CHCT services (16%). The mean age of index cases was 36.9 years (SD ±7.5). These index cases elicited 46,717 biological children for community-based HIV testing, corresponding to a child-to-index ratio of 1.6. Slightly more than half of the children were female (52%), with a mean age of 8.7 years (SD ±3.5). More than half resided in the Amhara and Oromia regions (54%), and 46% lived in woreda-level towns (Table 1).

Table 1: Socio-demographic characteristics of HIV- positive index cases and their children (Index =29,293, Children =46,717).

Variables		*Frequency (N)*	*Percentage (%)*
Children sex, (N = 46,717)	Female	24,460	52.4
	Male	22,257	47.6
Children Age (in years),	Between 1.6 and 3	1823	3.9
(N = 46,717)	3 - 4	4927	10.5
	5 - 9	18874	40.4
	10 - 14	21093	45.2
Region	Addis Ababa	6661	14.3
(N = 46,717)	Amhara	15,000	32.1
	Gambella	2590	5.5
	Tigray	3547	7.6
	Oromia	10166	21.8
	SNNP	8753	18.7
Children residence where Index case received HIV care & treatment service	Capital city	6661	14.3
(N = 46,717)	Regional & Zonal town	18434	39.5
	Woreda Town	21622	46.3
Number of children elicited per index case ratio	One child	15,375	32.9
(N = 46,717)	Two children	18,317	39.2
	Three children	8979	19.2
	Four or more children	4046	8.7
HIV-positive Index case Sex (N = 29,293)	Female	20,852	71.2
	Male	8,441	28.8
HIV-positive Index case age range in year	18 - 24	817	2.8
(N = 29,293)	25-29	3227	11.0
	30-34	6014	20.5
	35-39	9244	31.6
	≥ 40	9991	34.1

HIV-positive Index case by source of line list received *(N = 29,293)*	Community	19433	66%
	Facility	5204	18%
	CHCT	4656	16%

3.2 **Clinical and Service-Related Characteristics of Index Cases and Their Biological Children**

At the time of elicitation, 10% were newly diagnosed with HIV, 51% were clinically stable, and 39.5% had documented ART adherence challenges. More than half of the index clients received HIV care and treatment services at the health center level. Furthermore, 45% of index clients notified their children and family members about HIV testing services, while 32% required the support of CEFs for notification and referral. In addition, among screed for intimate partner violence, 3.7% of index cases were screened positive.

Table 2: Clinical and client related characteristics of HIV- positive index cases (n =29,293, Children =46,717).

Variables		*Frequency (N)*	*Percentage (%)*
Index case Status at the time of elicitation	New Positive	2933	10.0
	Stable	4615	15.8
	Poor Adherence	9736	33.2
	Interruption in treatment	786	2.7
	High viral load	671	2.3
	More than one adherence factors	373	1.3
	Status not mentioned	10179	34.7
Index case notification plan	Client referral	13133	44.8
	Contractual referral	3981	13.6
	Dual referral	2789	9.5
	Provider referral	2634	9.0
	Not mentioned	6756	23.1
Index case IPV Screening result	Screen negative	10117	34.5
	Screen positive	389	1.3
	Not documented	18787	64.1
The type of health facility index case received HIV care and treatment by its biological children	Hospital	18481	39.6
	Health Center	26482	56.7
	Other private and OVC service	1754	3.8

3.3 Pediatric Index Case Testing Cascade and HIV Positivity

All 46,717 identified children underwent HIV testing. Of these, 563 were newly diagnosed with HIV, yielding an overall positivity rate of 1.2% (95% CI: 0.79–1.61%). Among children diagnosed with HIV, 558 (99.1%) were successfully linked to HIV care and treatment services.

HIV positivity decreased with increasing child age. The highest positivity was observed among children aged 1.6 to <3 years (5.6%), followed by those aged 3–4 years (1.8%), 5–9 years (1.0%), and 10–14 years (0.9%) (Figure 1).

3.4 HIV Positivity among selected sociodemographic and clinical characteristics of index cases and their biological children

HIV positivity was slightly higher among male children (1.3%) compared with females (1.1%). Highest positivity rates were observed in Oromia (1.8%), Gambella (1.5%), and Amhara (1.2%), while the lowest were recorded in Addis Ababa and Tigray (0.8%). Children residing in woreda-level towns had higher positivity (1.6%) compared with those in regional or zonal towns (0.9%) and the capital city (0.8%).

Children of female index cases had higher HIV positivity (1.3%) than those of male index cases (1.0%). Positivity was highest among children of index cases aged 18–24 years (4.2%). By source of index case identification, positivity was highest among children of index cases identified through health facilities (1.3%) and lowest among those identified through community-based HIV care and support services (0.7%).

Positivity was also higher among children of newly diagnosed index cases (3.1%) and those whose index cases had multiple ART adherence challenges (2.8%). The lowest positivity (0.7%) was observed among children of clinically stable index cases (Table3).

Table 3. HIV-positivity among biological children by selected sociodemographic and clinical characteristics, 2025, (N =46,717)

Children sex	Female	24460 (52.4)	263 (1.1)
	Male	22257 (47.6)	300 (1.3)
Children Age Range in year	1.6 - < 3	1823 (3.9)	102 (5.6)
	3 - 4	4927 (10.5)	89 (1.8)
	5 - 9	18874 (40.4)	185 (1)
	10 - 14	21093 (45.2)	187 (0.9)
Region	Addis Ababa	6661 (14.3)	54 (0.8)
	Amhara	15000 (32.1)	177 (1.2)
	Gambella	2590 (5.5)	40 (1.5)
	Tigray	3547 (7.6)	27 (0.8)
	Oromia	10166 (21.8)	179 (1.8)
	SNNPR (currently 4 region)	8753 (18.7)	86 (1.0)
Residence	Capital city	6661 (14.3)	54 (0.8)
	Regional & Zonal town	18434 (39.5)	172 (0.9)
	Woreda Town	21622 (46.3)	337 (1.6)
Index sex	Female	33091 (70.8)	425 (1.3)
	Male	13626 (29.2)	138 (1.0)
Index Age Range	18 - 24	1156 (2.5)	49 (4.2)
	25 - 29	5041 (10.8)	91 (1.8)
	30 - 34	9550 (20.4)	132 (1.4)
	35 - 39	14963 (32)	153 (1.0)
	40 and above	16007 (34.3)	138 (0.9)
Index Source	Community	31376 (67.2)	389 (1.2)
	Health Facility	8325 (17.8)	122 (1.5)
	CHCT	7016 (15)	52 (0.7)
Type Health Facility	Hospital	18481 (39.6)	193 (1)
	Health Center	26482 (56.7)	345 (1.3)
	Other private and OVC	1754 (3.8)	25 (1.4)

Index case's notification plan	Client Referral	31556 (67.5)	343 (1.1)
	Contractual Referral	6442 (13.8)	88 (1.4)
	Dual Referral	4522 (9.7)	53 (1.2)
	Provider Referral	4197 (9)	79 (1.9)
Number of Children elicited	One child	15375 (32.9)	374 (2.4)
	Two children	18317 (39.2)	121 (0.7)
	Three children	8979 (19.2)	47 (0.5)
	Four or more children	4046 (8.7)	21 (0.5)
Index case clinical and adherence status at the time when elicited their child	Stable	6957 (14.9)	47 (0.7)
	New Positive	4934 (10.6)	153 (3.1)
	Poor Adherence	15412 (33)	129 (0.8)
	Interruption in treatment	1068 (2.3)	14 (1.3)
	High viral load	1288 (2.8)	17 (1.3)
	Multiple adherence factors	527 (1.1)	15 (2.8)
	Status not documented	16531 (35.4)	188 (1.1)

Stratified analysis showed that HIV positivity was highest among children aged 1.6 to <3 years whose index cases were aged 18–24 years (16.5%). Positivity declined with increasing index case age, reaching 1.8% among those aged ≥40 years. Similarly, among children of newly diagnosed index cases, positivity was highest in the 1.6 to <3-year age group (14.9%) and decreased with increasing child age, from 6.7% among those aged 3–4 years to 1.7% among those aged 10–14 years (Table 4).

Table 4: HIV-positivity yield among children by age group, index case status in Ethiopia (N =46,717)

Variable		*1.6 - < 3 yrs old*		*3-4 yrs old*		*5-9 yrs old*		*10-14 yrs old*	
		Positive	Yield	Positive	Yield	Positive	Yield	Positive	Yield
Index cases Status	New Positive	34	14.9%	36	6.9%	48	2.3%	35	1.7%
	adherence problems	28	5.2%	16	1.0%	58	0.8%	73	0.8%
	Current Status not mentioned	35	4.1%	31	1.5%	68	1.1%	54	0.8%
	Clinical stable	5	2.6%	6	0.8%	11	0.4%	25	0.8%
Index cases' Age Range	18-24	21	16.5%	13	5.1%	15	3.1%	0	0.0%
	25-29	24	7.4%	16	2.1%	36	1.5%	15	1.0%
	30-34	28	6.1%	22	2.0%	48	1.2%	34	0.9%
	35-39	22	4.5%	18	1.3%	50	0.8%	63	0.9%
	≥ 40	7	1.6%	20	1.4%	36	0.6%	75	0.9%

3.5 Predictors of HIV Positive case detection among biological children of HIV positive index cases

Bivariate and multivariable logistic regression analyses were conducted to identify factors associated with HIV positivity among biological children of HIV positive index cases. Independent variables included child and index case sociodemographic characteristics, index case clinical and adherence status, and service-related factors. Variables with p values <0.20 in the bivariate analysis and biologically plausible factors were included in the multivariable model.

In the multivariable analysis, region of residence was significantly associated with child HIV positivity. Children of index cases residing in Oromia, Amhara, and Gambella had higher odds of HIV positivity compared to those in Addis Ababa (AOR = 2.11; 95% CI: 1.54–2.89, AOR = 1.91; 95% CI: 1.39–2.64, and AOR = 1.75; 95% CI: 1.13–2.72, respectively).

Child age and index case age were strong predictors. Children aged 1.6– <3 years and 3–4 years had higher odds of HIV positivity compared to those aged 10–14 years (AOR = 5.51; 95% CI: 4.26–7.14 and AOR = 1.79; 95% CI: 1.38–2.32). Likewise, children of index cases aged 18–24, 25–29, and 30–34 years were more likely to test HIV positive than those aged ≥40 years (AOR = 2.97; 95% CI: 2.08–4.22, AOR = 1.57; 95% CI: 1.19–2.07, and AOR = 1.38; 95% CI: 1.08–1.77).

Service-related factors also showed significant associations. Children of index cases receiving HIV care at health centers had higher odds of HIV positivity than those receiving care at hospitals (AOR = 1.24; 95% CI: 1.03–1.49). Additionally, children identified through community-based and health facility index case lists had higher odds of HIV positivity compared to those identified through CHCT services (AOR = 1.64; 95% CI: 1.19–2.27 and AOR = 1.49; 95% CI: 1.03–2.14).

Index case clinical status remained a strong predictor. Children of newly diagnosed index cases had nearly fourfold higher odds of HIV positivity compared to children of clinically stable clients (AOR = 3.90; 95% CI: 2.76–5.51). Multiple adherence challenges were also associated with increased odds of child HIV positivity (AOR = 3.48; 95% CI: 1.99–6.38). Other sociodemographic, clinical and service-related variables were not significantly associated with child HIV positivity (Table 5).

Table 5: Predictors of HIV-positive yield among children: bivariate and multivariable binary logistic regression, 2025, (N =46,717).

Variables		*Children HIV Positive, N (%)*	*Binary logistic regression analysis*	
			Bivariate	Multivariate
			COR (95% CI)	AOR (95% CI, P. Value)
Children sex	Male	300 (1.3)	1.26 (1.06 - 1.48)	1.23 (1.041 - 1.458, 0.015) *
	Female	263 (1.1)	Ref	Ref
Children Age Range in year	1.6 - < 3	102 (5.6)	6.63 (5.18 - 8.48)	5.51 (4.258 - 7.14, < 0.001) *
	3 - 4	89 (1.8)	2.06 (1.6 - 2.65)	1.79 (1.376 - 2.316, < 0.001) *
	5 - 9	185 (1.0)	1.11 (0.9 - 1.36)	1.02 (0.831 - 1.256, 0.838)
	10 - 14	187 (0.9)	Ref	Ref
Index Source	Community	389 (1.2)	1.68 (1.257 - 2.248)	1.64 (1.185 - 2.269, 0.003) *
	Health Facility	122 (1.5)	1.99 (1.437 - 2.76)	1.49 (1.029 - 2.144, 0.034) *
	CHCT	52 (0.7)	Ref	Ref
Region	Addis Ababa	54 (0.8)	1	1
	Amhara	177 (1.2)	1.46 (1.08 - 1.98)	1.91 (1.385 - 2.638, < 0.001) *
	Gambella	40 (1.5)	1.92 (1.27 - 2.9)	1.75 (1.132 - 2.721, 0.012) *
	Tigray	27 (0.8)	0.94 (0.59 - 1.49)	1.04 (0.636 - 1.694, 0.849)
	Oromia	179 (1.8)	2.19 (1.62 - 2.98)	2.11 (1.536 - 2.893, < 0.001) *
	SNNPR (Currently 4 Region)	86 (1.0)	1.21 (0.86 - 1.71)	1.04 (0.724 - 1.481)
Index Age Range	18 - 24	49 (4.2)	5.09 (3.65 - 7.09)	2.97 (2.084 - 4.219, < 0.001) *
	25 - 29	91 (1.8)	2.11 (1.62 - 2.76)	1.57 (1.192 - 2.074, 0.001) *
	30 - 34	132 (1.4)	1.61 (1.27 - 2.05)	1.38 (1.083 - 1.765, 0.009) *
	35 - 39	153 (1)	1.19 (0.94 - 1.5)	1.15 (0.907 - 1.445, 0.254)
	40 and above	138 (0.9)	Ref	Ref
Type health facility	Hospital	193 (1)	1	1
	Health Center	345 (1.3)	1.25 (1.05 - 1.49)	1.24 (1.027 - 1.487, 0.025) *
	Other private and OVC	25 (1.4)	1.37 (0.9 - 2.08)	1.14 (0.732 - 1.762, 0.570)
Index case clinical and adherence status at the	Stable	47 (0.7)	Ref	Ref
	New Positive	153 (3.1)	4.71 (3.39 - 6.54)	3.9 (2.761 - 5.509, < 0.001) *

time when elicited their child	Poor Adherence	129 (0.8)	1.24 (0.89 - 1.74)	1.18 (0.839 - 1.657, 0.342)
	IIT	14 (1.3)	1.95 (1.07 - 3.56)	1.52 (0.829 - 2.798, 0.176)
	HVL	17 (1.3)	1.97 (1.13 - 3.44)	1.51 (0.856 - 2.678, 0.154)
	Had more than one factors	15 (2.8)	4.31 (2.39 - 7.76)	3.48 (1.899 - 6.379, < 0.001) *
	Status not documented	188 (1.1)	1.69 (1.23 - 2.33)	1.27 (0.909 - 1.773, 0.161)

**Significant association to positive yield in multiple binary logistic regression analysis with P< 0.05.*

Abbreviations: COR, crude odds ratio; AOR, adjusted odds ratio; CI, confidence interval; Ref, reference category

4. Discussion

This study assessed HIV positivity among biological children aged 1.6–14 years of index cases in Ethiopia and found an overall positivity rate of 1.2%. This estimate is below the World Health Organization (WHO) thresholds for elimination of mother-to-child transmission (MTCT) of HIV (<2% in non-breastfeeding populations or <5% in breastfeeding populations) [13]. However, this lower overall rate likely reflects the broader age range included in the analysis, whereas WHO indicators primarily focus on children around the end of breastfeeding (18–24 months). Consistent with this, HIV positivity increased to 5.6% among children aged 1.6 to <3 years, exceeding the WHO benchmark.

These findings are consistent with evidence from community-based index testing programs in sub-Saharan Africa. A multi-country scoping review reported HIV positivity rates ranging from 4.0% to 5.8% among children identified through index testing [24], which aligns with our estimates among younger children. Similarly, a study from Malawi reported a positivity rate of 4.0% among children and youth [25]. In contrast, the overall estimate in this study is comparable to findings from Lesotho and Côte d'Ivoire, where pediatric HIV positivity rates were approximately 1.4% [26,27].

The observed HIV positivity rate is lower than the 2.1% reported in the Ethiopian HIV/AIDS National Strategic Plan (2021–2025) [28]. This difference likely reflects variations in case-finding approaches. National estimates are largely derived from facility-based testing, where symptomatic children and clinically unstable index cases are more likely to be identified. In contrast, the present study relied predominantly on community-based platforms in PEPFAR-supported regions, which tend to include more clinically stable individuals and may identify children who are missed by conventional facility-based services.

Several factors were independently associated with HIV positivity among children. Marked regional disparities were observed, with higher odds in Oromia, Amhara, and Gambella compared with Addis Ababa. These differences may reflect contextual challenges such as conflict, population displacement, service

disruption, and socioeconomic vulnerability, all of which can limit access to antenatal care, maternal HIV testing and retesting, sustained ART use, and early infant diagnosis, thereby increasing the risk of vertical transmission.

Child age was a strong predictor of HIV positivity. Children aged 1.6 to <3 years had significantly higher odds of HIV infection compared with those aged 10–14 years. This pattern is consistent with regional evidence showing that majority of new pediatric HIV infections occur among children aged 0–4 years [29]. Studies from Ethiopia similarly demonstrate a declining risk of HIV infection with increasing age [30], likely reflecting survival bias and the impact of earlier diagnosis and treatment among older children.

Index case age was also significantly associated with child HIV status. Children of index cases aged 18–24 years had higher odds of HIV positivity compared with those whose index cases were aged ≥40 years. Although limited evidence from Ethiopia directly examines this relationship, existing literature suggests that younger women may face increased risk of MTCT due to delayed HIV diagnosis, suboptimal antenatal care utilization, inconsistent ART adherence, unintended pregnancies, and challenges with disclosure [31,32].

The source of index case identification was another important determinant. Children identified through community and facility-based index case lists had higher HIV positivity than those linked through CHCT services. This may be explained by the comprehensive support provided through CHCT programs, including psychosocial services, economic strengthening, mental health support, and disclosure counseling, which can enhance ART adherence and reduce transmission risk [23].

Finally, the clinical status of the index case was strongly associated with child HIV positivity. Children of newly diagnosed index cases or those with multiple adherence challenges were significantly more likely to be HIV positive compared with children of clinically stable individuals. These findings are consistent with existing evidence highlighting the importance of early HIV diagnosis, timely ART initiation, sustained adherence, and viral suppression in reducing MTCT risk [32–34].

Overall, these findings highlight the critical role of community-based index case testing in identifying previously undiagnosed HIV-positive children. Strengthening targeted testing strategies, improving early diagnosis among young women, and expanding community-based HIV care and support services are essential to accelerate progress toward elimination of pediatric HIV in Ethiopia and similar high-burden settings.

5. Strengths and Limitations of the Study

A major strength of this study is the use of routinely collected, quality-assured program data derived from primary client records, reflecting real-world implementation of community-based HIV testing services. The multi-center design and large, diverse cohort of index cases and their biological children enhance the external validity of the findings and support their generalizability across similar high-burden settings in Ethiopia. Furthermore, the study provides actionable programmatic evidence to inform strategies for improving pediatric HIV case detection and advancing progress toward the first “95” target among children through community-based testing approaches.

However, several limitations should be considered. The retrospective design and reliance on routine program data limited the availability of important variables, including socioeconomic and educational status, breastfeeding practices, and PMTCT follow-up. In addition, the absence of qualitative data restricted the ability to explore contextual, behavioral, and health system factors influencing pediatric HIV positivity. Although key confounders were addressed in the analysis, residual confounding cannot be excluded. Future prospective mixed-methods studies are recommended to provide a more comprehensive understanding of service quality, care pathways, and contextual determinants influencing pediatric HIV case detection.

6. Conclusion and Recommendation

This study demonstrates that community-based pediatric index testing is an effective strategy for identifying previously undiagnosed pediatric HIV cases, particularly among populations with limited engagement in facility-based services. The findings highlight that the clinical stability of index cases, coupled with robust CHCT support, plays a critical role in reducing the risk of mother-to-child transmission.

Overall, the results emphasize the value of targeted, community-based testing approaches in strengthening pediatric HIV case identification. These findings support the continued integration and potential scale-up of community-based testing for biological children of HIV-positive index cases as part of comprehensive national HIV testing strategies, with a focus on improving timely linkage to care and treatment in resource-limited settings.

Abbreviations

AIDS	Acquired immunodeficiency Syndrome
AOR	Adjusted Odds Ratio
ART	Antiretroviral Therapy
CEF	Community Engagement Facilitator
CHCT	Community HIV Care and Treatment
CI	Confidence Interval
HIV	Human Immunodeficiency Virus
MTCT	mother-to-child transmission
OVC	Orphans and Vulnerable Children
PEPFAR	President's Emergency Plan for AIDS Relief
PLHIV	People Living with HIV
PMTCT	Prevention of Mother-to-Child Transmission
SD	Standard Deviation
SNNPR	Southern Nations, Nationalities, and Peoples' Region
SPSS	Statistical Package for the Social Sciences
UDS	Unified Data System
UNAIDS	United Nations Program on HIV/AIDS
WHO	World Health Organization

Declarations

Ethics approval and consent to participate

Ethical approval to analyze the program data for this study was obtained from the Ethiopian Public Health Association's Institutional Review Board / Ethical Review Committee (Reference No. EPHA/OG/859/25). The approval covered the retrospective analysis of routinely collected program data. During routine service delivery, informed consent was obtained from parents or legal guardians, and assent was obtained from pediatric participants as appropriate. For this study, all data were de-identified prior to analysis and no personal identifiers were included. Confidentiality of participants was strictly maintained. The study was conducted in accordance with the principles of the Declaration of Helsinki and relevant national guidelines.

Consent for publication

Not applicable

Availability of data and materials

Due to the sensitive nature of programmatic information related to pediatric and HIV services, the data supporting this study are not publicly accessible. De-identified datasets are available from the corresponding author upon request

Competing Interests

The authors declare no financial, professional, or personal competing interests related to this manuscript and have no affiliations or involvement with any organization that could influence the work reported.

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Authors' contributions

Author 1 was responsible for the conceptualization and design of the study, performed the primary data analysis, drafted the manuscript, and led the overall development and finalization of the paper.

Author 2 provided primary guidance throughout the research, critically reviewed the manuscript at multiple stages, and approved the final version.

Authors 3–15 contributed valuable feedback and suggestions that improved the content, structure, and clarity of the manuscript, helping to shape its final version. Finally, all authors read and approved the final manuscript.

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Figures

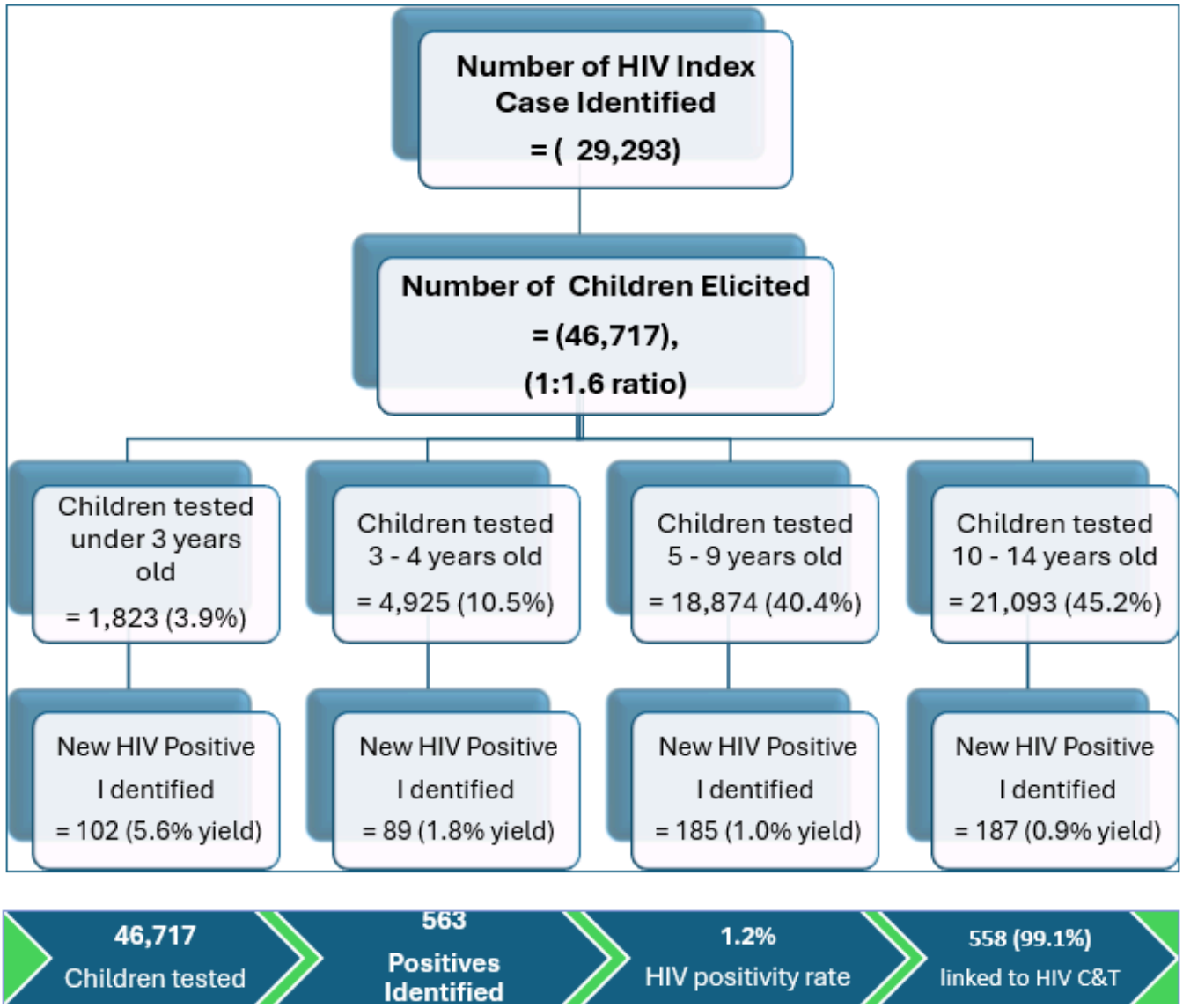


Figure 1

Pediatric index testing cascade and HIV-positivity yield by children age group, 2021–2025 (N =46,717).

Supplementary Files

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