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Impact of Surge 2.0 intervention to enhance pediatric HIV cascades outcomes in Nairobi and Kajiado Counties, Kenya: A Quasi-Experimental Study

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Impact of Surge 2.0 intervention to enhance pediatric HIV cascades outcomes in Nairobi and Kajiado Counties, Kenya: A Quasi-Experimental Study

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Abstract

Background

Despite global progress in HIV treatment, pediatric coverage continues to lag behind adult populations. The USAID Fahari ya Jamii project implemented Surge 2.0, a targeted, data-driven intervention to enhance pediatric HIV cascade outcomes in Nairobi and Kajiado Counties, Kenya. This study assessed the impact of the intervention and compared outcomes between the two counties.

Methods

We conducted a quasi-experimental study employed a pre-post study across 50 high-volume health facilities (29 in Nairobi, 21 in Kajiado). The six-week intervention (January-June 2022) included case management, joint caregiver-child appointments, optimized ART regimens, and real-time monitoring using electronic medical records and dashboards. Outcomes included HIV positivity, ART initiation, and viral load suppression. Paired t-tests were used to assess differences pre- and post-intervention.

Results

A total of 2,839 children were tested. HIV positivity increased from 1.56% (24/1540) pre-intervention to 2.85% (37/1299) post-intervention (p=0.017). The highest positivity rate was among children aged 1-4 years at 3.34% (12/359). Index testing had highest yield of 3.36% (23/684). Kajiado recorded higher positivity at 4.78% (16/335) compared to Nairobi at 2.18% (21/964). Same-day ART initiation improved from 47.8% (11/23) to 61.3% (19/31). Viral suppression improved from 89.8% (608/677) to 91.1% (680/747), with significant improvement observed in Kajiado County (p=0.0302).

Conclusion

Surge 2.0 improved pediatric HIV case identification, ART initiation, and viral suppression particularly in rural settings. Data driven, multi-strategy approaches are effective in strengthening pediatric HIV programs and should be scaled up.

Keywords:

Pediatric HIV, Surge intervention, index testing, vital suppression, Kenya, HIV cascade

Background

The global response to pediatric HIV has seen significant progress, yet disparities persist. According to the UNAIDS 2023 Global Report, in 2022, 84% of children (aged 0-14 years) living with HIV knew their status, 84% of those diagnosed were on antiretroviral therapy (ART), and 74% of children on treatment had achieved viral suppression (1). These figures lag behind adult treatment coverage and viral suppression rates, underscoring the need for intensified efforts to close the pediatric treatment gap.

In sub-Saharan Africa, where the largest HIV burden exists, pediatric HIV coverage has improved but remains suboptimal compared to adult populations. The rates of viral suppression among people on treatment in Eastern and Southern Africa have reached 93%, yet children continue to face barriers to testing and treatment. Some countries, including Botswana, Eswatini, Rwanda, Tanzania, and Zimbabwe, have reached the 95-95-95 targets, while others, such as Kenya, are making targeted improvements to bridge existing gaps, particularly among children and adolescents (1,2).

According to KENPHIA 2018, Kenya had made notable progress toward the UNAIDS targets, achieving 79-96-91 among adults living with HIV . However, coverage among children living with HIV lagged behind with estimates at 79-93-67, highlighting significant gaps in pediatric treatment and viral suppression (2–4). To address these gaps, the USAID Fahari ya Jamii project developed and implemented Surge 2.0 intervention, an approach designed to accelerate (Surge) targeted pediatric HIV interventions, ensuring equity across all sub-populations. The project, a collaboration between the University of Nairobi's School of Medicine and the county governments of Nairobi and Kajiado, supported 167 health facilities (110 in Nairobi and 57 in Kajiado). Through partnerships with faith-based organizations, local service delivery partners, and community-based organizations, Fahari ya Jamii aimed to improve pediatric HIV outcomes by aligning strategies with real-time data and community-specific needs.

A review of seven studies in Africa highlights the impact of Surge interventions on HIV case identification and treatment access (5–11). In West Africa, two studies in Nigeria demonstrated that integrating community-based case identification with facility-level strategies significantly increased pediatric HIV diagnoses, ART coverage, and retention (7,9). Similarly, data-driven interventions and demand-creation activities in Rivers State accelerated the ART scale-up (12).

In Southern Africa, Mozambique's I-Surge in Zambezia province improved retention through differentiated service delivery models such as decentralized drug distribution and multi-month dispensing (8). Meanwhile, Malawi's Tingathe Surge adopted a multi-strategy approach, utilizing index case testing, enhanced provider-initiated testing and counseling (PITC), and community-based testing to improve case identification and linkage rates, particularly among men and adolescents (11).

While these studies provide strong evidence of Surge's impact on the general population, there remains a gap in data regarding its effectiveness among children aged 0–14. Further research is needed to assess whether the intervention yields similar improvements in pediatric case identification, linkage, and treatment outcomes.

This study had three main aims: (1) to assess the effect of Surge 2.0 intervention on HIV testing, linkage to treatment, and viral suppression among children aged 0-14 years, (2) to compare intervention outcomes between Nairobi and Kajiado Counties, and (3) to identify key success

factors, best practices, and lessons learned to inform data-driven decision-making for policymakers, program managers, and healthcare practitioners.

Methods

Study design

The study design was quasi-experimental with a pre-and post-intervention period to highlight changes in performance indicators before and after implementing Surge 2.0 intervention. This involved comparing baseline data to data collected during and after the intervention to determine whether improvements had occurred. Further comparative analysis was done to compare indicator performance between different healthcare facilities in two counties (Nairobi and Kajiado) and analyze any regional disparities in intervention outcomes, as well as a longitudinal analysis to observe trends and changes.

Setting

Surge 2.0 initiative was executed over six weeks, focusing on 50 high-volume healthcare facilities in Nairobi and Kajiado counties. These facilities were strategically chosen as they contributed to approximately 90% of PLHIV served by the program.

Study population

Intervention Group: 50 high-volume healthcare facilities in Nairobi and Kajiado counties that implemented Surge 2.0 intervention.

Comparison Group: Comparison with the period before Surge *2.0* intervention (pre-intervention data) to assess changes.

The Intervention

From Surge to Surge 2.0

PEPFAR's original Surge strategy is a high-intensity, data-driven designed to rapidly accelerate HIV program performance, particularly in geographic areas or populations lagging behind in epidemic control. The strategy aims to quickly improve outcomes such as HIV testing, treatment initiation, and viral load suppression through intensified efforts over a defined period (13,14). Uganda implemented its Surge strategy March 2018, making it one of the earliest adopters. Initially, the initiative focused on high-volume sites with implementing partners carrying out

project-specific interventions to reach target populations and report results to Surge dashboards integrated within the PEPFAR In-country Reporting System (PIRS) (5,14,15).

Kenya adopted and implemented Surge in May 2019, intending to accelerate progress toward HIV epidemic control. USAID Fahari ya Jamii leveraged key lessons learned from the implementation of Surge to re-define and re-imagine its approach, aiming to accelerate HIV prevention and treatment outcomes among pediatric clients.

Surge 2.0 built on the original Surge intervention by refining strategies for pediatric HIV case identification, treatment initiation, and viral suppression, with a stronger emphasis on data-driven decision-making and differentiated service delivery. Unlike the original Surge, which had a broad focus, Surge 2.0 prioritized pediatric populations, addressing gaps in HIV case identification among children aged 0–14 years. It introduced optimized index testing and risk-based screening to improve efficiency and targeted community-based approaches, such as mobile outreach, home-based ART initiation, and community refills, to enhance linkage and retention.

A key distinction between Surge and Surge 2.0 was the greater use of real-time data analytics, leveraging EMR and performance dashboards to guide decision-making at facility and county levels in Surge 2.0. Additionally, Surge 2.0 strengthened collaboration with county health teams, ensuring integration into routine services for sustainability. These refinements made Surge 2.0 more targeted, data-driven, and system-oriented, improving HIV outcomes for vulnerable populations while fostering long-term program sustainability.

Surge 2.0 was implemented within 50 high-volume facilities (29 in Nairobi and 21 in Kajiado), contributing to 87% of program performance. The intervention lasted six weeks, extending to June 2022, to assess sustainability beyond the initial intervention phase, as the 6-week duration was insufficient to demonstrate the impact on some indicators.

Activation

Surge 2.0 facility activation took place in January 2022. From then until March 2022, sub-county-based mentors, hub leads, and technical leads conducted daily monitoring and reporting of Surge 2.0 indicators, focusing on pediatric HIV prevention and treatment cascades. Facility and program teams monitored progress weekly, on an agreed date, virtually or in-person

The program ensured effective execution through a multifaceted approach. Twenty-five mentors, each assigned to two facilities for daily follow-up, ensured that schedules for mentors and program leads were aligned with set priorities and monitored. Targeted interventions for identified gaps were defined and deployed accordingly.

The program identified key areas for improvement, including increasing pediatric index testing to over 95%, enhancing linkage to treatment to exceed 95%, and achieving 100% viral load coverage. To address these gaps, several implementation steps were undertaken. These included line listing, case management, and eligibility screening for HIV testing, as well as introducing joint caregiver-child (family) appointments to strengthen follow-up and ensure timely treatment initiation.

Additionally, on-site refresher trainings on EMR utilization were conducted to improve data accuracy and use in decision-making. An integrated checklist was developed and deployed on the Kobo Collect app to facilitate real-time monitoring and mentorship. A total of 25 mentors were trained to support daily and weekly tracking of key performance indicators.

Additionally, we utilized virtual platforms to guide caregivers on the importance, benefits, and interpretation of their results. To improve VLS to over 95%, we optimized ART, managed children with suspected treatment failure through the viremia clinics, and implemented U=U. We also provided case management and facilitated peer-to-peer learning for all treatment preparation, adherence counselors, and adolescent champions.

Monitoring and evaluation

The monitoring strategy involved setting weekly facility targets and conducting daily monitoring at the patient level. A facility Surge dashboard captured and reviewed Surge data weekly, while weekly data reviews tracked the progress and fidelity of implementation. All facility teams met weekly to review the previous week's data before forwarding it to the Hub Leads. Weekly work improvement team (WIT) meetings also addressed identified performance gaps. Short learning loops and small tests of change identified effective strategies for quick scale-up, while the team discarded ineffective ones. The Technical Team also conducted bi-weekly deep dive reviews for each work stream.

Data management and analysis

Variables

This study's primary focus was evaluating the effects of Surge 2.0 intervention on improving HIV prevention and treatment indicators. The design included distinct variables, each playing a unique role in analyzing the intervention's impact.

Surge 2.0 Intervention served as the main independent variable. This intervention was central to the study, representing structured, data-informed efforts to enhance HIV service delivery. By examining this variable (looking at its specific strategic activities), the study sought to understand how the targeted actions within Surge 2.0 influenced key HIV prevention and treatment outcomes.

Demographic factors offered a nuanced understanding of the intervention's impact across various population segments. Categorizing patients by age group allowed for age-specific analyses, revealing if the intervention was more effective for specific age groups. Evaluation based on sex-specific outcomes revealed whether the intervention impacted males and females differently, providing insight into each group's unique challenges or successes.

The dependent variables consisted of the targeted HIV indicators, specifically those that Surge 2.0 intervention aimed to improve. These included case identification or the number of new HIV cases identified through testing and outreach efforts, linkage to treatment, viral load (VL) uptake and coverage among pediatrics, and viral load suppression among pediatrics. These indicators served as measures of the intervention's success, capturing changes in key aspects of HIV care.

Two control variables helped contextualize the findings and accounted for external influences. Region/County (Nairobi/Kajiado) categorized healthcare facilities by location (either Nairobi or Kajiado), allowing for an assessment of regional disparities in intervention impact. This geographic perspective highlighted whether the intervention's effectiveness varied between different settings. The period pre/post Surge 2.0 enabled a comparison of indicator performance before and during the intervention, providing insight into its effectiveness. This time-based variable allowed a before-and-after analysis, revealing any shifts in outcomes that coincided with the intervention's implementation.

Statistical analysis

Data were extracted from the Fahari ya Jamii case-based surveillance system and the Kenya Health Information System (KHIS). Categorical variables were summarized using frequencies and percentages and presented in contingency tables, while continuous variables were summarized

using means (standard deviations) or medians (interquartile ranges), as appropriate, to describe demographic and clinical characteristics such as age, sex, county, and testing modality. Pre- and post-Surge differences in key HIV outcomes—including HIV positivity, ART initiation, and viral load suppression, were assessed using the Chi-square test or McNemar test, as appropriate, to compare categorical variables. Statistical significance was set at $\alpha = 0.05$. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated from contingency tables to estimate the strength of associations. Multivariable logistic regression models were used to evaluate the association between the surge period (pre vs. post) and outcomes including HIV positivity and linkage to ART care, adjusting for relevant covariates. A non-parametric Mann–Kendall trend test was applied to assess temporal trends in viral load suppression over time. All analyses were conducted at the facility level across 50 health facilities, with stratified analyses by county (Nairobi and Kajiado) to assess regional differences in program performance. Statistical analyses were performed using R statistical software version 4.5.2.

Ethical Considerations

Ethical approval was obtained from the Kenyatta National Hospital-University of Nairobi Ethics and Research Committee, approval number P688/09/2024. A waiver of parental consent was obtained for all analyses drawn from data extraction and abstraction because this utilized routinely collected data and involved no more than minimal risk to the participants. In addition, the waiver would not adversely affect the rights and welfare of the participants

Results

HIV Testing outcomes Pre- and Post-Surge 2.0 intervention

A total of 2,839 children were tested for HIV, with 1540 tested pre-implementation (October 2021 – December 2021) and 1299 tested during implementation (April 2022 – June 2022). HIV case identification increased significantly from 1.56% (24/1540) pre-Surge 2.0 period to 2.85% (37/1299) in the post-Surge 2.0 period (p=0.008). Increases were observed across both sexes, with a 2.11% rise among the males compared to a 0.55% among females.

Case identification improved across all age groups on the post-Surge 2.0 period, with the greatest gains among children over 5 years the highest positivity rate among the 1–4 age group 3.34% (12/359) (Table 1). Of the 37 children identified as HIV-positive post-Surge, 32% (12/37) were 1-4 years, 49% were 5-9% (18/37), and 19% (7/37) were 10-14 years. Among the children aged 1-

14 years, 59.4% (22/37) were male; a 17.7% increase from the pre-Surge 2.0 period . HIV case identification was highest among younger children <10 years (4.3 times more than the 10-14 age group) post-Surge 2.0, especially in the 5-9 age group.

Table 1:HIV testing outcomes among children in Nairobi and Kajiado pre- and post-Surge 2.0 intervention

Children Characteristics	**Pre-Surge 2.0(Oct 2021-Dec 2021)**			**Post-Surge 2.0(Apr 2022-Jun 2022)**		
	Number Tested(n)	**HIV Positive**	**Yield (%)**	**Number Tested(n)**	**HIV Positive**	**Yield (%)**
Overall	1540	24	1.56%	1299	37	2.85 %
Gender						
Female	849	14	1.65%	681	15	2.20%
Male	691	10	1.45%	618	22	3.56%
Age group						
1-4	434	6	1.38%	359	12	3.34%
5-9	732	12	1.64%	622	18	2.89%
10-14	374	6	1.60%	318	7	2.20%
County						
Kajiado	275	4	1.45%	335	16	4.78%
Nairobi	1265	20	1.58%	964	21	2.18%
Modality of Testing						
Index	757	10	1.32%	684	23	3.36%
Other PITC	499	8	1.60%	398	7	1.76%
Other testing modalities[1]	284	6	2.11%	217	7	3.23%
Facility type						
Faith-Based	166	1	0.60%	203	3	1.48%
Ministry of Health (Public facilities)	1260	20	1.59%	903	30	3.32%
NGOs[2]	42	0	0.00%	33	0	0.00%

[1] Other testing modalities include testing at pediatric special clinic, pediatric ward, Tuberculosis clinic, antenatal clinic, voluntary counselling and testing room and through social network services.
[2] NGO – Non-Governmental Organization-based facilities

Private	72	3	4.17%	160	4	2.50%

Data in table 1 above is derived from the DATIM platform (16).

Overall HIV testing yield significantly increased from the Pre-Surge 2.0 period to the Post-Surge 2.0 period. During October–December 2021, 1,540 children were tested, with 24 testing HIV positive, resulting in a yield of 1.56%. In contrast, between April–June 2022, 1,299 children were tested and 37 were HIV positive, yielding 2.85%. Despite fewer children being tested in the post-surge period, the proportion testing positive was significantly higher ($p = 0.008$), indicating an overall improvement in case identification efficiency during the post-surge phase.

In the post-Surge 2,0 period, the testing yield was higher among males at 3.56% compared to their female counterparts 2.20% .HIV testing strategies yielded varying results, with the highest yield from index testing at 3.36% and the lowest from PITC at 1.76%. in the post-Surge period. Other testing modalities, including inpatient department (IPD), outpatient department (OPD), and screening at malnutrition clinics, collectively had a yield of 3.23%

Kajiado County, which is mainly considered rural but has significant peri-urban areas, had more HIV-positive cases identified (4 times higher than the pre-implementation period) with positivity of up to 4.78% The largest relative increase in testing and case identification occurred in public health facilities, accounting for 81.8% of overall testing and 83.3% of case identification.

Table 2: : Comparison of HIV Positivity by Child Characteristics Before and After Surge 2.0 (October–December 2021 vs April–June 2022), Including p-Values, Odds Ratios, and 95% Confidence Intervals.

Children Characteristics	**Pre-Surge 2.0, N (%)**	**Post-Surge 2.0, N (%)**	**Sub-total, N (%)**	**p-value**	**OR**	**95% CI**
Gender						
Female	14(58)	15(41)	29(48)	0.11	2.05	0.82–5.17
Male	10(42)	22(59)	32(52)			
Age group						
1-9 years	18(75)	30(81)	48(79)	0.47	1.29	0.45–3.71
10-14 years	6(25)	7(19)	13(21)			
County						
Kajiado	4(17)	16(43)	20(33)	0.01	3.81	1.22–11.9

Nairobi	20(83)	21(57)	41(67)			
Modality of Testing						
Index	10(42)	23(62)	33(54)	0.04	2.3	1.03–5.15
Other PITC	14(58)	14(38)	28(46)			
Facility type						
Ministry of Health (Public facilities)	20(83)	30(81)	50(82)	0.63	1.17	0.36–3.83
Others	4(17)	7(19)	11(18)			

There was an overall increase in HIV positivity from Pre-Surge 2.0 to Post-Surge 2.0 across most subgroups. Among females, cases increased from 14 to 15 and among males from 10 to 22, though the difference by gender was not statistically significant (OR = 2.05, 95% CI: 0.82–5.17; p = 0.11). Similarly, HIV positivity rose in both age groups (1–9 years: 18 to 30; 10–14 years: 6 to 7), but this change was not statistically significant (OR = 1.29, 95% CI: 0.45–3.71; p = 0.47). In contrast, children from Kajiado County showed a significant increase compared to Nairobi (4 to 16 vs. 20 to 21), with nearly fourfold higher odds in the post-surge period (OR = 3.81, 95% CI: 1.22–11.9; p = 0.01). HIV positivity identified through Index testing also significantly increased (10 to 23 vs. 14 to 14 in Other PITC), with more than double the odds post-surge (OR = 2.30, 95% CI: 1.03–5.15; p = 0.04). However, differences by facility type were not statistically significant (OR = 1.17, 95% CI: 0.36–3.83; p = 0.63).

In the logistic regression analysis assessing factors associated with the post-surge period, county and testing modality were significantly associated with being in the post-surge period (see additional file 1: Table S1). Children from Kajiado County had nearly four times higher odds of being in the post-surge period compared to those from Nairobi (OR = 3.92, 95% CI: 1.42–10.2; p = 0.012). Similarly, children tested through Index testing had 2.7 times higher odds of being in the post-surge period compared to those tested through other PITC modalities (OR = 2.70, 95% CI: 1.55–4.14; p = 0.032). Gender, age group, and facility type were not significantly associated with the Surge 2.0 intervention. Males had higher odds compared to females (OR = 2.35, 95% CI: 0.77–5.27; p = 0.223), and children aged 10–14 years had slightly higher odds compared to those aged 1–9 years (OR = 1.44, 95% CI: 0.45–3.71; p = 0.511), but these differences were not statistically

significant. Facility type (Other vs Public) also showed no significant association (OR = 1.17, 95% CI: 0.39–3.84; p = 0.612).

Linkage to treatment for children diagnosed with HIV

Overall, ART coverage increased from 95.8% . In the pre-Surge 2.0 period to 100% in the post-Surge period. The overall median age and IQR were 5.31 (2.31-10.31). There was no significant difference (p>0.05) in children's demographics and clinical characteristics initiated on ART pre- and post-Surge 2.0. By county, Nairobi accounted for 60.95% of children initiated on ART in the pre-Surge 2.0 period and 64.5% (20/31) in the post-Surge 2.0 period (Table 2).

Same-day ART initiation rates improved from 47.8% in the pre-Surge 2.0 period to 61.3% in the post-Surge 2.0 period. In the post-Surge 2.0 period, ART coverage was highest in the 1–4 years age group at 61.3% and lowest among 5-9 years at 12% . On average, there was no delay between HIV-positive identification and ART initiation in the post-Surge 2.0 period, indicating that ART was started immediately or on the same day in the post-Surge period.

Table 3:Linkage to ART among children in Nairobi and Kajiado pre- and post-Surge 2.0 intervention

	Pre-Surge 2.0 (Oct 2021- Dec 2021)	**Post-Surge 2.0(Apr 2022 -Jun 2022)**	**Overall**	**P-value**
Characteristics	**n=23**	**n=31**	**n=54**	
Median(IQR) Time to Linkage	0.0(0.0-42.0)	0.0(0.0-42.0)	0.0(0.0-42.0)	
Median (IQR) Age	6.31(2.31-9.81)	4.31(2.31-10.31)	5.31(2.31-10.31)	
Age group (%)				
1-4Yrs	10 (4 3.5)	19 (61.3)	29	0.083
5-9yrs	9 (39.1)	4 (12.9)	13	
10-14Yrs	4 (17.4)	8 (25.8)	12	
Gender (%)				
Female	16 (69.6)	13 (41.9)	29	0.082
Male	7 (30.4)	18 (58.1)	25	

County (%)				
Kajiado	9 (39.1)	11 (35.5)	20	1
Nairobi	14 (60.9)	20 (64.5)	34	
Time to Linkage (%)				
Same Day	11 (47.8)	19 (61.3)*	30	
1 Day to 2 Weeks	3 (13.0)	3 (9.7)	6	0.616
More than 2 Weeks	9 (39.1)	9 (29.0)	18	
Baseline WHO Staging (%)				
Stage 1	21 (91.3)	23 (74.2)	44	0.268
Stage 2	1 (4.3)	5 (16.1)	6	
Stage 3	1 (4.3)	3 (9.7)	4	

Table 4: : Comparison of Linkage to HIV Care Among HIV-Positive Children Before and After Surge 2.0 (October–December 2021 vs April–June 2022), Including p-Values, Odds Ratios, and 95% Confidence Intervals

Characteristics	Pre-Surge 2.0	Post-Surge 2.0	Overall	p-value	OR	95% CI
Age group						
1-10Yrs	19(83)	23(74)	42(78)	0.47	1.65	0.49–5.59
10-14Yrs	4(17)	8(26)	12(22)			
Gender						
Female	16(70)	13(42)	29(54)	0.03	3.17	1.12–9.02
Male	7(30)	18(58)	25(46)			
County						
Kajiado	9(39)	11(35)	20(37)	0.53	1.29	0.50–3.33
Nairobi	14(61)	20(65)	34(63)			
Time to Linkage						
Same Day	11(48)	19(61)	30(56)	0.18	1.74	0.77–3.94
More than 1 Day	12(52)	12(39)	24(44)			
Baseline WHO Staging						
Stage 1	21(91)	23(74)	44(81)	0.04	3.65	1.03–12.9
Other Staging	2(9)	8(26)	10(19)			

Linkage to HIV care among HIV-positive children showed some variation between the Pre- and Post-Surge 2.0 periods. Although linkage was higher among children aged 1–10 years compared to those aged 10–14

* Improvement in same-day linkage to treatment from diagnosis

years, this difference was not statistically significant (OR = 1.65, 95% CI: 0.49–5.59; p = 0.47). Gender differences were significant, with females demonstrating over three times higher odds of linkage compared to males (OR = 3.17, 95% CI: 1.12–9.02; p = 0.03). No significant difference was observed by county (OR = 1.29, 95% CI: 0.50–3.33; p = 0.53). While same-day linkage increased in the post-surge period, this was not statistically significant (OR = 1.74, 95% CI: 0.77–3.94; p = 0.18). However, baseline WHO staging was significantly associated with linkage, with children in Stage 1 having significantly higher odds of linkage compared to those in other stages (OR = 3.65, 95% CI: 1.03–12.9; p = 0.04). Results show the significant differences in linkage were observed by gender and baseline WHO stage, but not by age group, county, or time to linkage.

In the logistic regression analysis examining factors associated with the surge period (pre vs post), gender and baseline WHO staging were significantly associated with being in the post-surge period (Additional file 1: Table S2). Male children had over three times higher odds of being in the post-surge period compared to females (OR = 3.17, 95% CI: 1.12–9.02; p = 0.02). Children with WHO staging other than Stage 1 had significantly higher odds of being in the post-surge period compared to those in Stage 1 (OR = 3.65, 95% CI: 1.03–12.9; p = 0.03). Age group, county, and time to linkage were not significantly associated with the surge period. Children aged 10–14 years had slightly higher odds compared to those aged 1–10 years (OR = 1.65, 95% CI: 0.49–5.59; p = 0.52), Kajiado County versus Nairobi (OR = 1.29, 95% CI: 0.50–3.33; p = 0.61), and same-day linkage versus linkage after more than one day (OR = 1.74, 95% CI: 0.77–3.94; p = 0.123), but none of these differences were statistically significant.

Viral suppression outcomes among children on ART

Overall, there was an improvement in viral suppression percentage across all age groups. The rate of patients with viral load results and those with suppressed viral load remained stable in both counties (Table 3). According to the 2023 Kenya ART Guidelines, viral load suppression is defined as having less than 1,000 copies of HIV RNA per milliliter of blood (4). A low Mann-Kendall non-parametric trend test yielded a low p-value (0.004) which is below the α=0.05 indicating a statistically significant positive trend in viral load suppression from October – December 2022 to January – March 2024. Viral load suppression improved from 89.8% in the period from October – December 2022 to 94.7% in the January – March 2024 period (Fig 1), with greatest gains observed among children 0-4 years and across the two counties.

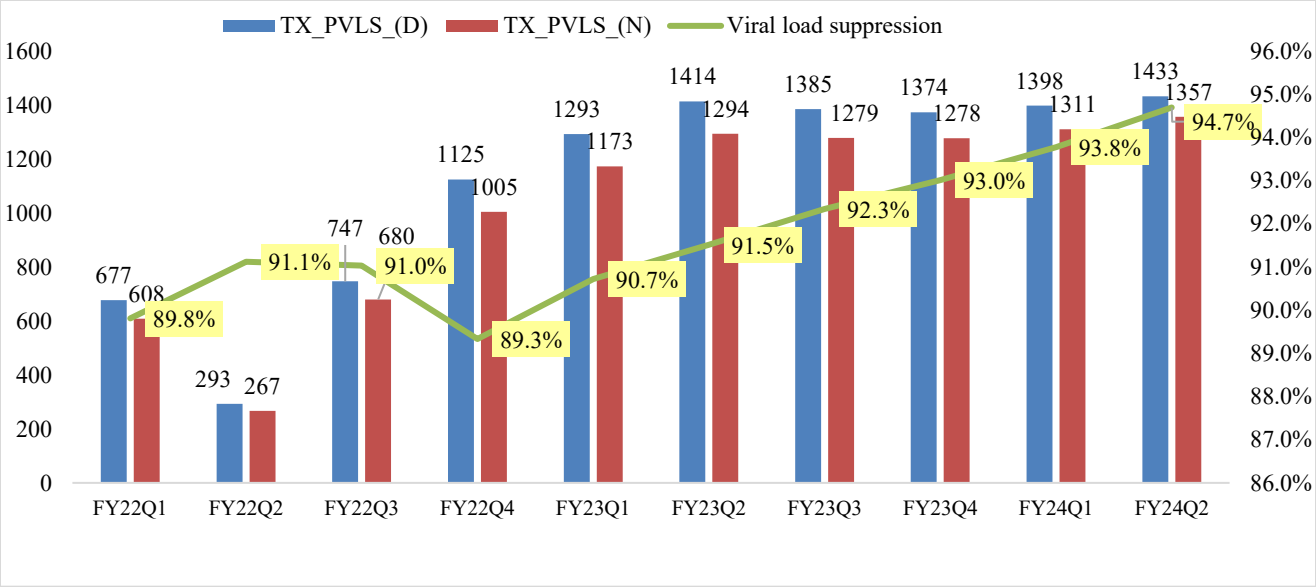


Figure 1: Viral suppression trends among children on ART in Nairobi and Kajiado pre- and post-Surge 2.0

Data derived from the DATIM Platform (16).

Table 5: County comparison of viral suppression among children in Nairobi and Kajiado pre- and post-Surge 2.0

Age Band (Years)	Pre-Surge 2.0 Suppression (Overall)	Post-Surge 2.0 Suppression (Overall)	P-value	Pre-Surge 2.0 Suppression (Nairobi)	Post-Surge 2.0 Suppression (Nairobi)	Pre-Surge 2.0 Suppression (Kajiado)	Post-Surge 2.0 Suppression (Kajiado)
0-4	54/73 (74%)	70/85 (82%)	0.966	37/48 (88%)	42/48 (88%)	17/25 (68%)	28/37 (76%)
5-9	212/239 (89%)	232/257 (90%)	0.938	151/168 (90%)	148/156 (95%)	61/71 (86%)	84/101 (83%)
10-14	342/365 (94%)	378/405 (93%)	0.688	236/244 (97%)	240/246 (98%)	106/121 (88%)	138/159 (87%)
Overall	608/677 (90%)	680/747 (91%)	0.261	424/460 (92%)	430/450 (96%)	184/217 (85%)	250/297 (84%)

Data derived from the DATIM Platform (16).

Data Source: DATIM Platform for Surge 2.0 Period,

Overall pediatric HIV cascade outcomes

Although the viral load suppression metrics did not show statistically significant changes, the improvement is programmatically meaningful. Table 4 highlights a statistically significant

increase ($p<0.05$) in case identification and linkage to ART between the pre-Surge and post-Surge periods.

Table 6: Pediatric HIV Cascade outcomes across testing, treatment initiation, and viral load suppression pre- and post-Surge 2.0 intervention

Variable	Pre-*Surge 2.0* (Oct-Dec 2021)	Post-Surge 2.0 (Apr-Jun 2022)	t-value	P-value	95% CI
HIV Testing	1540	1299	1.65	0.11	(1.06,-10.70)
HIV Case Identification	24	37	-2.22	0.03	(-0.50, -0.03)
Case Identification %	1.56	2.85	-2.56	0.01	(-0.03, -0.00)
Treatment initiation	23	49	-3.62	0.00	(-0.81, -0.23)
Proxy Linkage%	95.83	132.43	-3.98	0.00	(-0.57, -0.19)
Valid viral load results	608	680	-0.870	0.39	(-4.77, 1.89)
Viral load suppression	677	747	-0.828	0.41	(-4.80, 2.0)
Suppressed %	89.8	91.1	-1.137	0.261	(-0.16, 0.04)

County comparison of pediatric HIV cascades outcomes

In Nairobi County, there was a significant increase in HIV testing post-implementation ($p=0.022$), contrasting with Kajiado County, where no significant change was observed($p=0.368$) Table 5). Case identification demonstrated a significant increase in Kajiado County post-implementation ($p=0.004$) while remaining stable in Nairobi County($p=0.813$).

Table 7: County comparison of pediatric HIV cascades outcomes pre- and post-Surge 2.0

Variable	**Pre-Surge 2.0 Nairobi**	**Post-surge 2.0 Nairobi**	**P-value**	**95% CI**	**Pre-Surge 2.0 Kajiado**	**Post-surge 2.0 Kajiado**	**P-value**	**95% CI**
HIV Testing	1265	964	0.022	(1.64,19.11)	275	335	0.368	(-9.33,3.61)

Case Identification	20	21	0.813	(-0.33,0.26)	4	16	0.004	(-0.94,-0.20)
Case identification (%)	1.58	2.18	0.262	(-0.01,0.00)	1.45	4.78	0.013	(-0.07,-0.01)
Treatment initiation	18	31	0.030	(-0.85,-0.05)	5	18	0.009	(-1.06,-0.18)
Proxy Linkage (%)	90	147.62	0.028	(-0.54,-0.03)	125	112.5	0.002	(-0.81,-0.20)
Valid Viral Load Results	424	430	0.939	(-5.7,5.29)	184	250	0.030	(-5.95,-0.33)
Viral Suppression	460	450	0.899	(-5.14,5.83)	217	297	0.0211	(-6.98,-0.63)
Suppression %	92.2	95.6	0.952	(-0.12,0.13)	84.8	84.2	0.117	(-0.32,0.04)

ART initiation significantly increased in Nairobi (p=0.030) and Kajiado (p=0.009) counties post-Surge 2.0. Proxy linkage to treatment significantly increased post-Surge 2.0 in Nairobi (p=0.028) and Kajiado (p=0.003) counties. No significant change was noted in the percentage of patients with suppressed viral loads in either county post-Surge (Nairobi: p = 0.952, Kajiado: p = 0.117). A significant increase in patients with suppressed viral loads was observed in Kajiado County post-Surge 2.0 (p = 0.030).

Discussion

Surge 2.0 findings suggest varying impacts on HIV-related outcomes during the period of Surge strategic activities across Nairobi and Kajiado Counties. Notably, an increase in testing, case identification, treatment initiation, and linkage to care signifies improvements in HIV care delivery with sustainability and scale-up potential. The intervention also demonstrated the feasibility of scaling up a multi-strategy approach in a programmatic setting, significantly increasing testing and case identification among children under 15 years of age (9,11,12). Index testing yielded the highest results at 3.36%, closely comparing with Nwanja et al. (2023), who reported a 3.1% yield in Southern Nigeria among a similar population (9).

Public health facilities played a key role in improving testing and case identification rates. While case identification increased across all age groups, it was highest among children over 5 years, suggesting that gaps in early diagnosis had previously existed and were effectively identified and addressed.

ART initiation rates among children improved significantly during Surge, rising from 47.8% to 61.3% on the same day of diagnosis. ART coverage also increased from 95% pre-implementation to over 100%, with the highest rates in children aged 1–4 years. Nairobi accounted for the largest number of children initiated on ART in both pre- and post-*Surge* phases. Despite these improvements, no significant differences in demographics or clinical characteristics of children initiated before and during Surge indicated the intervention's broad impact across groups, possibly because of the short interval between pre- and post-Surge 2.0 intervention.

County comparisons

When comparing results between counties, Nairobi saw a significant increase in HIV testing (p=0.022) following Surge, whereas no such significant change was observed in Kajiado (p=0.368). This discrepancy highlights the need for tailored approaches in different regions to maximize the effectiveness of HIV testing efforts. Regarding case identification, Kajiado County experienced a significant improvement (p=0.004), while Nairobi remained stable (p=0.813), suggesting that Kajiado's intervention strategies were particularly effective at identifying new cases.

Both counties showed significant increases in ART initiation post-Surge, with Nairobi at (p=0.03) and Kajiado at (p=0.009). There was also a marked improvement in linkage to treatment, with proxy measures showing significant increases in both counties (Nairobi: p=0.028; Kajiado: p=0.0028). These results underscore the effectiveness of Surge in getting individuals into treatment and improving access to care.

However, when looking at viral load suppression, there was no significant change in either Nairobi (p=0.952) or Kajiado (p=0.117) in the post-Surge period. Nevertheless, Kajiado did show a statistically significant increase in viral suppression (p=0.030), which indicates that, in this region, additional factors may have contributed to better outcomes in this specific area.

The greater improvements in Kajiado County may reflect the effectiveness of intensive mentor-led follow-up in lower-volume, peri-urban/rural facilities, where targeted interventions can be implemented more uniformly. In contrast, high patient volumes and service delivery pressures in Nairobi may limit the consistency of intervention delivery despite greater infrastructure availability. These findings highlight the importance of tailoring pediatric HIV interventions to local health systems.

Results from this study demonstrate a notable increase in HIV positivity among children during the post-Surge 2.0 period compared to the pre-Surge period. HIV case identification increased across most subgroups, with males showing a larger absolute increase than females, although gender differences were not statistically significant. Similarly, children aged 1–9 years and 10–14 years both experienced higher positivity in the post-surge period, but these differences were not significant. In contrast, children from Kajiado County had nearly fourfold higher odds of testing positive compared to those from Nairobi, and Index testing was associated with significantly higher positivity compared to other PITC modalities. Facility type did not significantly influence HIV positivity, highlighting that geographic location and targeted testing strategies played a more substantial role in identifying HIV-positive children.

Linkage to ART among HIV-positive children improved overall in the post-surge period, with coverage reaching 100% compared to 95.8% pre-surge. Same-day ART initiation also increased from 47.8% to 61.3%, particularly among younger children aged 1–4 years. Logistic regression analyses indicated that gender and baseline WHO staging were significant predictors of linkage, with males and children with WHO stages other than Stage 1 showing higher odds of being linked during the post-surge period. Other factors, including age group, county, and time to linkage, were not significantly associated with post-surge linkage, suggesting that improvements in linkage were consistent across these subgroups.

Generally, the results indicate that the Surge 2.0 interventions were effective in increasing HIV case detection and improving linkage to care among children. Targeted testing approaches, particularly Index testing and efforts in higher-burden counties like Kajiado, were associated with higher HIV positivity. Similarly, enhanced ART initiation strategies, including same-day linkage, contributed to universal coverage post-surge.

In summary, while the strategic activities domains of Surge 2.0 intervention led to substantial improvements in case identification, ART initiation, and linkage to treatment, the lack of significant changes in viral suppression suggests that further strategies are needed to address this outcome. The differences between Nairobi and Kajiado emphasize the need for region-specific adjustments to optimize results. Future efforts should further enhance viral load suppression, particularly in regions like Nairobi, while continuing to build on the successes seen in case identification and treatment initiation.

Key success factors, best practices and lessons learned

Surge 2.0 made significant strides in improving pediatric HIV care through enhanced case identification and treatment linkage, particularly among children. The program prioritized index testing for children of PLHIV and strengthened HIV exposed infant (HEI) screening at six weeks, achieving over 95% coverage (9,10,12). Key best practices included integrating technology for real-time monitoring, such as the Kobo Collect Android App, and using virtual platforms to educate caregivers about viral load testing and treatment adherence. Mentorship was also crucial, with mentors providing daily support to facilities, ensuring continuous follow-up and timely interventions to address service delivery gaps.

The initiative also focused on improving treatment linkage, particularly for children under 2 years, through dedicated case management and proactive caregiver follow-up. Additionally, establishing support networks for caregivers facilitated peer-to-peer learning and shared experiences, enhancing treatment adherence. Surge 2.0 utilized a data-driven approach with weekly data reviews and performance tracking to identify effective strategies, which were quickly scaled up.

An integrated checklist was integral in this process, serving as a prompt and standard operating procedure (SOP) for coordinated service delivery. This ensured sustainability and limited fragmented care for pediatric patients, helping health workers deliver comprehensive, timely, and standardized interventions. The program's emphasis on ART optimization, viremia clinics, and the Undetectable=Untransmissible (U=U) strategy led to improvements in viral load suppression to over 95% in Nairobi County (10,11). On the whole, the combination of activities in Surge 2.0, that included technological integration, mentorship, and caregiver support created a solid foundation for context-sensitive, sustainable improvements in pediatric HIV care. In the evolving strategy of

integrated approaches to HIV care, with other morbidities (within or outside HIV) there is still more to learn on how Surge 2.0 would fit into this programmatic recommendation.

Limitations of the study

This study had several limitations. First, reliance on routine programmatic data from multiple sources may have introduced inconsistencies in data completeness and quality. Second, the short duration of the intervention limits the assessment of long-term sustainability of observed gains (11). Third, the quasi-experimental pre-post design without a control group limits the causal attribution of observed changes solely to intervention. Finally, findings from high-volume facilities in Nairobi and Kajiado may not be generalizable to lower-volume or differently resourced settings.

Conclusions and recommendations

The Surge 2.0 intervention demonstrated notable improvements in HIV testing, case identification, ART initiation, and viral suppression among children across various demographics. These findings underscore the importance of continued surveillance and targeted interventions to address the evolving HIV epidemic among children in diverse healthcare settings. Despite some limitations in the study design, these results provide critical insights for policymakers and program implementers to refine and scale up differentiated HIV testing strategies, aiming to end pediatric HIV/AIDS by 2030.

One of the primary findings is the significant increase in testing and case identification rates, particularly among children under 15, underscoring the impact of high yield testing methods like index testing. Scaling up such targeted testing approaches, especially within family and index testing frameworks, holds potential as a high-impact strategy for identifying undiagnosed cases in high-prevalence areas.

Another important insight is the notable rise in same-day ART initiation rates, which increased from 47.8% to 61.3% during Surge period. This emphasizes the value of rapid access to treatment upon diagnosis. For implementers, institutionalizing same-day ART initiation across facilities could enhance health outcomes for people living with HIV and help curb transmission rates. Streamlining operational processes to enable same-day ART initiation is critical in improving timely treatment uptake.

These findings also highlight the essential role of public health facilities in achieving these outcomes, as they were instrumental in delivering testing and treatment services. Public facilities thus play a crucial role in reaching underserved populations and bridging access gaps. Strengthening support for these facilities, including bolstering supply chains and workforce capacity, will be vital in sustaining progress in HIV care delivery.

Additionally, while case identification increased across all age groups, it was highest among older children, pointing to missed opportunities for early diagnosis in younger populations. Routine early diagnostic screening for HIV within pediatric and antenatal care can help address these gaps. Further, these findings reveal regional variations in viral load suppression rates, with stable rates in Nairobi and increases in Kajiado. These differences suggest that localized, adaptive approaches considering specific community and facility characteristics are essential to enhance intervention effectiveness.

Finally, the success of Surge 2.0 informed approaches such as index testing, real-time data use for decision-making, and rapid ART initiation, can maximize impact per unit of investment. By leveraging existing program infrastructure, prioritizing high-yielding interventions, and strengthening county-led adaptive implementation and mentorship systems, HIV programs can sustain progress and accelerate epidemic control for children, even in the face of shrinking fiscal space (17).

Abbreviations

ART: Antiretroviral therapy

EMR: Electronic Medical Records

HEI: HIV Exposed infant

HIV: Human Immunodeficiency Virus

RNA: Ribonucleic Acid

SOP: Standard Operating Procedure

UNAIDS: United Nations Programme on HIV/AIDS

WIT: Work Improvement Team

Additional Files

Additional file 1: Table S1

Table S 1:: Multivariate Logistic Regression Output with Coefficients and 95% confidence intervals pre- and post-Surge 2.0

Predictor	B	S.E.	Wald	df	Sig.	Exp(B)	95% CI for Exp(B)
Gender (Male vs Female)	0.718	0.472	2.316	1	0.223	2.35	0.77 – 5.27
Age (10–14 vs 1–9)	0.254	0.54	0.221	1	0.511	1.44	0.45 – 3.71
County (Kajiado vs Nairobi)	1.338	0.582	5.292	1	0.012	3.92	1.42 – 10.2
Modality (Index vs PITC)	0.833	0.409	4.144	1	0.032	2.7	1.55 – 4.14
Facility Type (Other vs Public)	0.157	0.54	0.085	1	0.612	1.17	0.39 – 3.84
Constant	−0.020	0.25	0.006	1	0.94	0.98	-

Additional file 1: Table S2

Table S 2:: Multivariable Logistic Regression Output with Coefficients and 95% Confidence Intervals HIV positive linkage pre and post Surge 2.0

Predictor	B	S.E.	Wald	df	Sig.	Exp(B)	95% CI for Exp(B)
Age (10–14 vs 1–10)	0.501	0.54	0.861	1	0.52	1.65	0.49 – 5.59
Gender (Male vs Female)	1.155	0.472	5.987	1	0.02	3.17	1.12 – 9.02
County (Kajiado vs Nairobi)	0.254	0.54	0.221	1	0.61	1.29	0.50 – 3.33
Time to Linkage (Same Day vs >1 Day)	0.554	0.409	1.832	1	0.123	1.74	0.77 – 3.94
WHO Staging (Other vs Stage 1)	1.295	0.582	4.944	1	0.03	3.65	1.03 – 12.9
Constant	3.121	0.244	0.006	1	0.93	0.97	—

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Author's contributions

SA conceptualized the study. SA and co-authors contributed to data curation, analysis, interpretation, and manuscript writing. All authors reviewed and approved the final manuscript

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Ethical approval and consent to participate

This study was approved by the Kenyatta National Hospital-University of Nairobi Ethics and Research Committee, approval number P688/09/2024. Administrative approvals were obtained from the National AIDS & STI Control Programme (NASCOP) and the county governments of Nairobi and Kajiado. A waiver of informed consent for this study was approved by Kenyatta National Hospital-University of Nairobi Ethics and Research Committee, approval number P688/09/2024.

Clinical Trial Number

Not applicable

Consent of publications

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request and with permission from the University of Nairobi and relevant regulatory bodies.

Competing interests

The authors declare that they have no competing interests.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryFile.xlsx