NBER WORKING PAPER SERIES

MORTALITY EFFECTS OF THE 2025 US AID FREEZE: EVIDENCE FROM ZAMBIA

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Working Paper 36054
http://www.nber.org/papers/w36054

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
November 2026

Figueiredo Walter, Moneke, and Radu declare no competing interests. Karlan declares no currently competing interests but was on detail from Northwestern University into USAID as the Agency Chief Economist from October 2022 until the end of February 2025 under the Intergovernmental Personnel Act. Zyambo is employed at the Zambian Ministry of Health and was the Chief HIV Clinical Mentor and ECHO Technical Lead from October 2023 until March 2025, and the Program Director HIV Prevention Program from April 2025 until present. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

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NBER Working Paper No. 36054
November 2026
JEL No. I15, O12, O19

ABSTRACT

We study the impact of the 2025 sudden freeze then subsequent thaw of US foreign aid on HIV prevention, treatment, infection, and death. In Zambia, HIV-related aid was administered through two agencies. Activities under one were disrupted for several months, and those under the other much less. Comprehensive data from all Zambian health facilities reveal immediate differential reductions in preventive HIV measures that mostly later recovered, followed by more HIV-positive pregnant women, more HIV-exposed births, more opportunistic infections, and more recorded deaths. For example, after one year we observe a 14% [95% CI: 3, 25] increase in HIV-positive pregnant women and a 26% [95% CI: 8, 45] increase in deaths among people living with HIV who were receiving antiretroviral therapy.

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Mortality Effects of the 2025 US Aid Freeze: Evidence from Zambia

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Abstract: We study the impact of the 2025 sudden freeze then subsequent thaw of US foreign aid on HIV prevention, treatment, infection, and death. In Zambia, HIV-related aid was administered through two agencies. Activities under one were disrupted for several months, and those under the other much less. Comprehensive data from all Zambian health facilities reveal immediate differential reductions in preventive HIV measures that mostly later recovered, followed by more HIV-positive pregnant women, more HIV-exposed births, more opportunistic infections, and more recorded deaths. For example, after one year we observe a 14% [95% CI: 3, 25] increase in HIV-positive pregnant women and a 26% [95% CI: 8, 45] increase in deaths among people living with HIV who were receiving antiretroviral therapy.

We study the consequences in Zambia of the January 2025 freeze of US foreign aid for HIV prevention, treatment, infection, and death over the following 15 months. The United States has long been the world's largest bilateral donor (*1*), and its President's Emergency Plan for AIDS Relief (PEPFAR), launched in 2003, was the largest commitment by any nation to a single disease: more than $100 billion was invested, 20.6 million people received antiretroviral therapy (ART) in 2024, and an estimated 26 million lives were saved (*2–4*). PEPFAR support includes HIV testing to detect infections, prevention services to avert new ones, and ART to suppress the virus, thus halting disease progression and most onward transmission. From its creation, PEPFAR's implementation was divided between the United States Agency for International Development (USAID) and the Centers for Disease Control and Prevention (CDC), which avoided duplication by specializing in separate geographies within countries (*5*, *6*) (supplementary materials, section S1).

On January 20, 2025, an executive order froze US foreign aid pending review, and stop-work orders halted PEPFAR support to Zambian health facilities whether it came through USAID or CDC (*7*). A waiver for life-saving humanitarian aid followed on February 1, and CDC-supported services resumed partially within days and fully within a month. USAID's did not: almost all USAID staff were put on leave, implementing partners could not obtain authorization to restart, and many USAID-funded activities remained disrupted until PEPFAR functions were transferred to the State Department later in 2025 (*8–12*). Most HIV prevention activities, including pre-exposure prophylaxis (PrEP) not aimed at preventing mother-to-child transmission, were excluded from the waiver (*8*). In Zambia, about 24,000 health workers received stop-work instructions, the national HIV commodity supply chain and sample-courier system stalled, and facilities rationed antiretrovirals by cutting multi-month dispensing from six to three months (which is likely to reduce retention in care since patients are more likely to miss refills when asked to visit clinics more often) (*10*, *13–15*) (supplementary materials, section S4).

Zambia, a country of 22 million with adult HIV prevalence of 8.7% (*16*), is well placed for

measuring the consequences of the US aid freeze. PEPFAR financed 84% of its HIV response and supported treatment for 1.3 million people in 2024 (*13*, *17*), and the agencies' responsibilities were split geographically: USAID supported service delivery in six provinces along the northern border and CDC in four along the southern border (Fig. 1a; supplementary materials, section S2). Their delivery models also differed. USAID funded NGOs and directly paid facility-level clinical and support staff, who provided care in 70% of facilities in five of its six provinces (*13*), whereas CDC worked through government structures from provincial health offices down to facilities (*7*, *18*).

The shutdown therefore hit USAID-supported provinces far harder than CDC-supported ones. We compare the two sets of provinces before and after the freeze in a difference-in-differences design, using monthly administrative data from the universe of Zambian health facilities (not just the PEPFAR-supported clinics) (*19*). Facilities in the two sets were observationally similar regarding their health service provision before the freeze (Fig. 1b; Materials and Methods). By using the CDC provinces as a comparison group for the USAID provinces, we are able to identify impacts of the USAID freeze that are not confounds from omitted variables that affect the health outcomes systematically across Zambia. This approach thus provides stronger identification of the treatment effect of the freeze on USAID, but does introduce an underestimate of the effect of the US government's overall aid freeze since our comparison group includes effects it experienced from the brief disruption in their funding and operations.

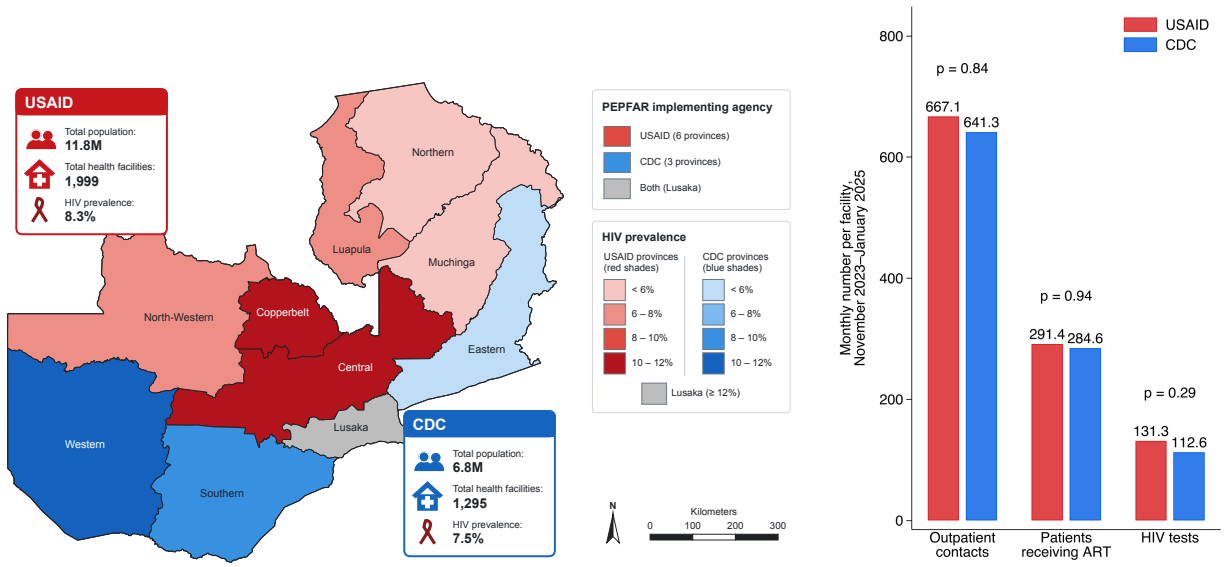
We find large disruptions to HIV prevention and HIV treatment in the short run in USAID-funded parts of the country, with most services recovering within six months. Thereafter, HIV infections, opportunistic infections, and HIV-related deaths start to rise, and remain elevated at the end of our sample in April 2026.

For HIV prevention, some measures such as testing and prophylaxis for individuals at high risk of infection rebound quickly within the first half of 2025, while others such as community awareness programs remain disrupted throughout the year. For HIV treatment, the number of patients receiving ART decreases in the short run. Later, health outcomes deteriorate in a sequence consistent with the disruption feeding through to infections and then deaths: from May 2025 onward the number of patients starting ART with an already advanced HIV infection rises sharply. More pregnant women are recorded as HIV-positive at their first antenatal care contact 10 to 15 months after the freeze, and the number of HIV-exposed births is higher 4 to 9 months after it. Finally, the number of ART patients who are recorded as having died increases about ten months after the shutdown, and appears to keep rising until the end of our sample.

The USAID shutdown does not only appear to have affected HIV-related care: we document pressure on the overall health system manifesting via large short-run reductions in patients (both inpatient and outpatient) attended to at health facilities.

We contribute to three strands of literature. First, we contribute to the literature studying the effects of the USAID shutdown, in particular work providing ex ante model estimates of its expected health effects (*13*, *20–24*). In contrast, we provide realized rather than model-predicted estimates of the shutdown's effects. In this regard, we relate to existing evaluations of the shutdown's effects on other outcomes such as conflict (*25*, *26*) and nighttime luminosity (*27*). In addition, we contribute to a growing literature documenting the disruption to HIV service delivery, which is hampered by relying on self-selected samples of health facilities (*11*, *28*) or PEPFAR administrative data, reporting of which itself was disrupted (*29*, *30*).

Second, we contribute to the literature on aid delivery modalities. In the trade-off for aid donors between engaging recipient governments and bypassing them, especially where governance



(a) Geographic split of service delivery support

(b) Health service provision

Fig. 1. Geographic split of service delivery support through USAID and CDC in Zambia

is weak (*31–33*), the latter comes at the potential expense of building state capacity (*34*), potentially even worsening it (*35–38*). We contribute a previously overlooked margin to this trade-off, namely the reliability and stability of donor engagement. Closest to ours is Kavakli and Rotondi's (*39*) study of the health effects of earlier aid restrictions. However, we would not interpret our results as indicative of the superiority of one modality over another, since modality is simply one dimension along which USAID and CDC differed in supporting health services in Zambia.

Third, we contribute to studies of the public health effects of interruptions to ART among HIV patients (*40*). Our work exploits the sudden disruption and gradual restart of ART to measure, at scale, the health and mortality consequences of a disruption to HIV service delivery that included interruptions to ART, in a population with a high HIV prevalence (*41*).

Results

Immediate disruption of HIV prevention and treatment

We present our main results in the form of twelve event studies in Fig. 2, illustrating the differential impact of the US aid freeze on health service delivery and health outcomes in USAID-supported and CDC-supported provinces between November 2023 and April 2026. We aggregate data into three-month blocks and distinguish between three post-freeze periods: a three-month period of immediate disruption from February to April 2025 followed by two six-month periods capturing short- and medium-run repercussions, respectively. Point estimates and confidence intervals for each of these periods are displayed as dashed lines and shaded boxes, and reported in table S3. The y-axis indicates the difference in monthly case counts, summed over all health facilities in USAID-supported provinces attributed to the (more) severe disruptions in these provinces. Additionally, Fig. 3 traces out the relative impact of the USAID shutdown across the three aforementioned periods, with point estimates and confidence intervals reported in table S4.

We find that the USAID shutdown disrupted both HIV prevention and HIV treatment. As Fig. 2 Panel 1 shows, the number of HIV tests conducted dropped by 173,000 in the first three months following the freeze, corresponding to a 22% decrease relative to the baseline period (November 2024 to January 2025). PrEP initiations fell even more drastically from 26,200 to 14,800 (-44%). Both of these activities recovered quickly, however, showing no statistically significant differences in later periods. Outreach activities, as captured by community meetings held by community health assistants, on the contrary, did not fall as quickly, but remained at lower levels until the end of our study period (-51%, 10 to 15 months after the freeze, statistically significant at the 10% level), in line with more permanent funding cuts for prevention activities aside from PrEP.

Unlike PrEP and other preventive measures, ART was exempted from the freeze by the waiver in early February as a life-saving measure. While fears of stockouts were nonetheless widespread, survey evidence suggests these rarely occurred in practice (*42*). Consistent with this, we observe a small decrease in the number of patients receiving ART (-3%, statistically significant at the 10% level). In contrast, the number of patients picking up their medication late or being categorized as lost to follow-up (LTFU) increased substantially ($+57\%$ and $+53\%$, respectively), as community outreach services, including appointment reminders, adherence support, and medication delivery, were severely curtailed (*42*). The recovery of these services also took substantially longer, with the impact on LTFU only dissipating in late 2025.

Rising infections, opportunistic infections, and deaths

While HIV prevention and treatment services recover, we detect increases in the number of HIV-positive pregnant women ($+14\%$ in November 2025–April 2026), HIV-exposed births ($+15\%$ in May–October 2025), and patients starting ART with advanced HIV ($+64\%$ November–December 2025, statistically significant at the 10% level) in the 15 months following the disruption (*43*). This is in line with predictions by Zambian public health experts shortly after the freeze, noting that "HIV is prone to resurging when services are disrupted", with the "largest number of additional HIV infections estimated to occur among women" (*13*), which would raise the risk of mother-to-child HIV transmission (we do not observe infant infections directly).

Tuberculosis notifications (for which PEPFAR also supported screening and treatment) are 21% higher 10 to 15 months after the freeze. Recorded meningitis cases are higher in all three periods (87%, 73%, and 118%). Both are consistent with newspaper reports of an "increase in the number of people living with HIV presenting with opportunistic infections" (*9*). Absolute increases in case numbers remain moderate, however. We estimate a total of 1,400 additional tuberculosis cases and 260 additional meningitis cases between late 2025 and early 2026.

Finally, deaths among ART patients increase markedly towards the end of our study period ($+26\%$, 10 to 15 months after the freeze), averaging 81 [95% CI: 24, 139] per month from November 2025 to April 2026, the third and final period in our data, by which the consequences of stopping ART can manifest. The total for the full 15 months sums to 625 excess deaths among persons living with HIV who were on ART [95% CI: -266, 1,665]. We show the sensitivity of excess ART deaths to ambiguity in the geographical coverage of USAID and CDC support (supplementary materials, table S10), and results include up to 963 excess ART deaths [95% CI: -134, 2,235] for the full 15 months.

However, we consider this an inferior, diluted measure of the consequence of the freeze since the first nine months appear unlikely to feature realized ART deaths from the freeze. In fact, the

first time period (February-April 2025) sees a reduction in ART deaths of 65 per month [95% CI: −129, 4], and we argue it likely represents a reduction in reporting, possibly due to LTFU, that could explain the increase in the second time period of roughly the same monthly magnitude. By the third time period, any reporting effect should no longer be germane, thus providing the most reliable estimate of reported ART deaths as a consequence of the freeze. This figure only represents reported deaths, and earlier research in Zambia found that lost-to-follow-up patients had a considerably higher mortality rate, suggesting a mortality rate that is 3.7 times the reported ART death rate (*44*). The increase in mortality is more likely due to treatment interruptions for those who had already been living with HIV rather than due to new infections.

Robustness

We report checks of pre-treatment orthogonality with respect to the USAID vs. CDC province allocation, differential reporting after the shutdown (shown two ways: first, explicitly testing for differential rates of entirely missing reporting sections, on the premise that an entirely missing section indicates lack of reporting rather than true zeros; second, examining treatment effects on placebo outcomes that should not react to the shutdown, such as Penta-3 vaccinations and road accidents), sample restrictions (Lusaka province in the comparison group; North-Western province excluded from the treatment group; a balanced panel), the level of aggregation (monthly, de-seasonalized data), and the data source (PEPFAR's reporting system) in supplementary materials, section S9.

Externalities on other health services

The shortage of health staff due to the USAID shutdown and the life-threatening nature of any disruptions to ART care likely imposed externalities on other health services and patients in USAID provinces. We test this hypothesis by examining two standard indicators of health facility service delivery for the general population. We find evidence of externalities that are consistent with basic triage activities in favor of at-risk patients: the point estimates in Fig. 4 imply 2.35 million fewer outpatient contacts [95% CI: −5.06 million, 0.11 million] and 103,000 fewer inpatient admissions [95% CI: −224,000, 16,000] in health facilities in USAID provinces over the 15 months after the freeze, particularly during the first nine months after the shutdown (table S13).

Discussion

We estimate the HIV transmission and mortality effects in Zambia of the US foreign aid freeze in early 2025. We find that 173,000 fewer HIV tests (−22%, [95% CI: −38, −3]) were conducted and 11,400 fewer patients started receiving PrEP (−44%, [95% CI: −84, −2]) in the three months after the freeze. HIV testing and PrEP recovered by the end of April 2025, although other HIV prevention measures remained cut and did not recover by the end of our data in April 2026. After May 2025, the numbers of HIV-positive pregnant women, HIV-exposed births, and severe cases of HIV rise, and HIV-positive pregnant women and advanced-HIV starts are highest in the last period. By 10 to 15 months after the disruption, tuberculosis increases; recorded meningitis cases are higher throughout. We observe 625 excess deaths among ART patients [95% CI: −266, 1,665] in USAID-supported provinces over the entire 15-month period after the freeze.

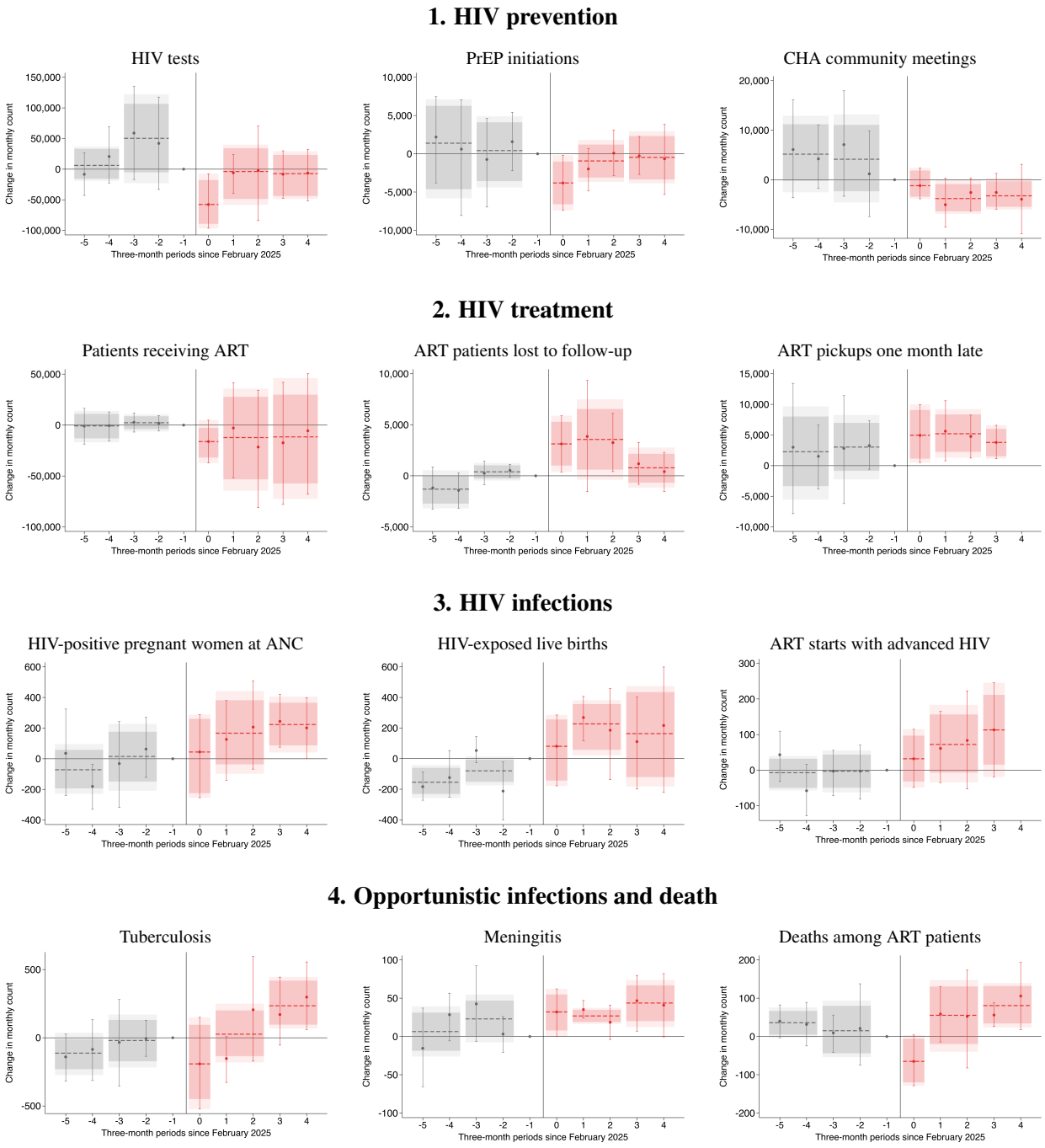


Fig. 2. Effect of USAID shutdown on HIV prevention, treatment, and health outcomes

All outcomes expressed as monthly number of cases, scaled by the number of USAID-supported facilities to represent the total treatment effect per month. All health facilities in Zambia that report to HMIS included in sample except for facilities in Lusaka province. Observations at the facility-period-level, where a period equals a three-month window. ART pickups one months late and ART starts with advanced HIV are only available until December 2025. Difference-in-differences specification with facility and period fixed effects, comparing USAID- to CDC- administered facilities across Zambian provinces. Red (gray) dots represent point estimates for the treatment (placebo) periods. Colored bars indicate 95% confidence intervals. Horizontal red (gray) dashed lines indicate the mean coefficient of each treatment (placebo) period three/six-month window, red (gray) boxes the corresponding 90% (darker) and 95% (lighter) confidence intervals. Standard errors are wild cluster bootstrapped at the province level using Webb weights on 9,999 replications and an imposed null.

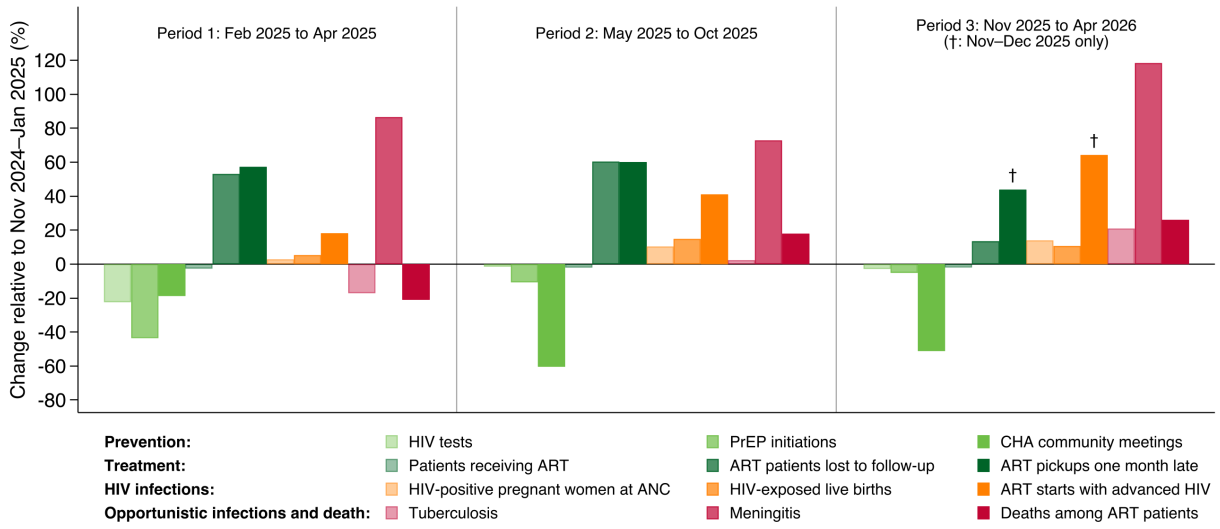


Fig. 3. Effect of USAID shutdown on health outcomes by post-shutdown period

All outcomes expressed as percentage change relative to November 2024-January 2025 period. Period 1 represents immediate disruption following US aid freeze, whereas Periods 2 and 3 capture short- and medium-run repercussions, respectively. All health facilities in Zambia that report to HMIS included in sample except for facilities in Lusaka province. Observations at the facility-period-level. Difference-in-differences specification with facility and period fixed effects, comparing USAID- to CDC- administered facilities across Zambian provinces.

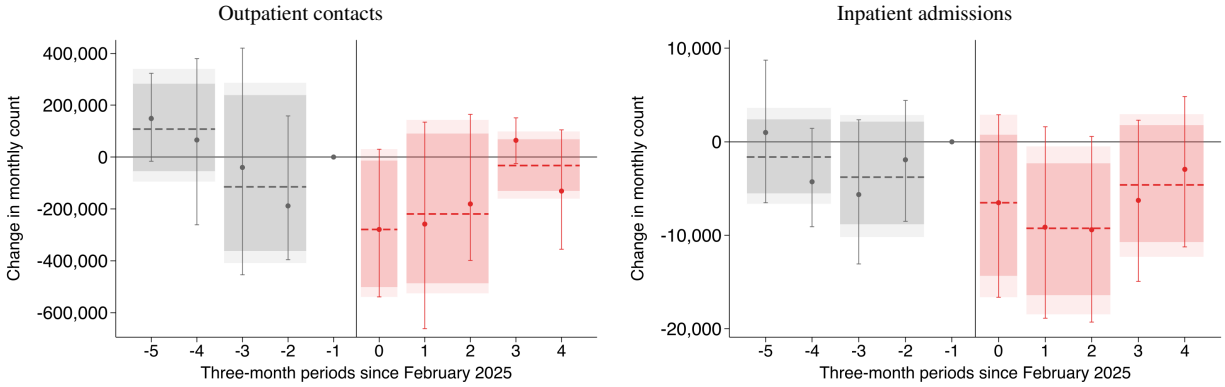


Fig. 4. Effect of USAID shutdown on health system service delivery

All outcomes expressed as monthly number of cases, scaled by the number of USAID-supported facilities to represent the total treatment effect per month. All health facilities in Zambia that report to HMIS included in sample except for facilities in Lusaka province. Observations at the facility-period-level, where a period equals a three-month window. Difference-in-differences specification with facility and period fixed effects, comparing USAID- to CDC- administered facilities across Zambian provinces. Red (gray) dots represent point estimates for the treatment (placebo) periods. Colored bars indicate 95% confidence intervals. Horizontal red (gray) dashed lines indicate the mean coefficient of each treatment (placebo) period three/six-month window, red (gray) boxes the corresponding 90% (darker) and 95% (lighter) confidence intervals. Standard errors are wild cluster bootstrapped at the province level using Webb weights on 9,999 replications and an imposed null.

Two papers projected Zambia's mortality effects from the freeze. Each operated under uncertainty with respect to the length or breadth of the freeze. Lining up our estimates to the model assumptions that mirror the duration of the actual freeze, we find our estimates to be conservatively in line with, but most likely higher than, the projected. The Zambian Ministry of Health's projection (*13*) estimated 32,550 additional HIV deaths over 2025 to 2060, most of them decades later among newly infected people. A seven-country model (*21*) assumed that 90% of people on ART

would default and re-initiate over six months once a waiver took effect, and projected 3,700 additional deaths in Zambia over 2025 to 2030 under its "Waiver-8 weeks" scenario. Supplementary materials, section S11 rescales deaths among those on ART to the time period and the provinces in our assessment, i.e., the six months starting November 2025 and the USAID provinces. The projections imply roughly 330 to 370 and 250 to 360 deaths, respectively. We record 486 [95% CI: 142, 837] excess deaths among ART patients in the final six months of our data. Whereas our estimate includes only registered deaths, their estimates include both registered and unregistered deaths. To adjust for unregistered deaths, we use Holmes *et al.* (*44*), a tracing study in 64 Zambian facilities that found those lost from contact were considerably more likely to have died, and suggested a 3.7x adjustment to account for actual HIV-related death. This adjustment increases our estimated excess deaths to about 1,800. Thus the consequences within the period observed were worse than projected, although the interruption of HIV treatment support was shorter than feared in several of the projections.

Further harm was mitigated partly by the Zambian public health system's response. The government reacted quickly to the USAID-driven layoff of approximately 24,000 health workers by launching a phased emergency action plan (*14*). Essential HIV services were prioritized and resources redirected to life-saving activities and patients at risk. This form of triage, while likely to have contained the mortality effects of the disruption, caused externalities on the wider health system and the Zambian public. For example, the point estimates imply 2.35 million fewer outpatient contacts [95% CI: −5.06 million, 0.11 million] and 103,000 fewer inpatient admissions [95% CI: −224,000, 16,000] through April 2026 (table S13). Furthermore, the literature has documented that increases in HIV infections and related deaths cause adverse effects on the uninfected, in particular the health and education of children of HIV-positive parents and the labor supply of caretakers (*45–48*). Adverse macroeconomic effects on growth may also ensue (*49*, *50*), and any increase in infections will raise future medical costs for the nation. Estimating the longer-term adverse consequences of these knock-on effects, including on mortality, is beyond the scope of this work.

Our estimates should also not be construed as an all-in estimate of the consequences of the USAID shutdown in Zambia given USAID's funding of services and commodities beyond PEPFAR, for example against malaria and food insecurity (*51*, *52*). Any disruption to such programs that provided funding across both sides of the USAID-CDC divide (guiding PEPFAR delivery) is differenced out in our estimates.

Beyond Zambia, survey evidence points to similar HIV service disruptions in more than 30 other countries following the US aid freeze, with particularly large reductions in HIV testing, pre-exposure prophylaxis, patient tracing, and adherence support (*11*, *28*).

In addition, the 2025 US foreign aid freeze in Zambia illustrates the risk of foreign donors setting up parallel structures for the provision of critical public services: whereas CDC mostly relied on a government-to-government setup to deliver PEPFAR services (*18*), USAID contracted local implementing partners such as NGOs and hired staff directly to work in government-run and private health facilities (*13*), effectively setting up a parallel system to the government-operated and -controlled one. Whereas such a parallel system can be (and was) switched off by a single stop-work order, government-run systems partially funded by donors may be more resilient: finance ministries can attempt to absorb fiscal shocks from the interruption of aid flows (*53*). However, since delivery modality is only one of several ways USAID and CDC differed, our estimates cannot isolate its role.

Therefore, our work also provides insights into the long-running debate on how aid should be delivered. In the trade-off between engaging recipient governments and bypassing them, especially where governance is weak (*31–33*), the latter comes at the potential expense of building state capacity (*34*). In fact, bypassing may not merely miss an opportunity to build state capacity, but could even worsen it: donor-funded implementing partners may draw staff and management capacity away from the public sector (*35*) and fragment the system into disease-specific silos (*36–38*). Our context highlights how the seemingly higher reliability of service delivery under the bypass system of parallel structures crucially depends on stable, long-term donor engagement, and is prone to donor disruption.

Materials and Methods

We compare changes in service delivery and health outcomes at health facilities in USAID- and CDC-supported provinces after the freeze in a difference-in-differences design with facility and period fixed effects. Standard errors are wild cluster bootstrapped at the province level (supplementary materials, section S7). November 2023 to January 2025 is the 15-month pre-period. February 2025 is the first treated period. The January 20, 2025 stop-work order halted both agencies, but the February 1 waiver let CDC resume while USAID activities remained suspended. Lusaka province, where both agencies supported service delivery, is excluded from the main sample (supplementary materials, section S2). The data are monthly administrative records from the Zambian Health Management Information System (HMIS) for 3,294 facilities, 95% of them public and 78% rural. USAID- and CDC-supported provinces were similar in facility type and ownership, and in service delivery and health services provision over the 15 months before the shutdown, with an aggregate test not rejecting equality of means ($p = 0.50$; Fig. 1b; tables S1 and S2; supplementary materials, section S5). The estimates represent difference-in-differences between the two sets of Zambian provinces before and after the shutdown and understate the full disruption for two reasons: CDC-supported facilities depended on the USAID-managed national supply chain and sample-courier system, such that HIV testing and ART initiations also fell at CDC-supported facilities (*30*), and the waiver excluded PrEP and other prevention activities on both sides. The HMIS is managed entirely by Ministry of Health staff and remained resilient throughout the entire study period, compared with the PEPFAR reporting system, which was severely disrupted after staff were put on leave.

USAID supported service delivery in Central, Copperbelt, Luapula, Muchinga, Northern, and North-Western provinces, and CDC in Eastern, Lusaka, Southern, and Western provinces. Two provinces are ambiguous. In Lusaka, CDC supported facility-level service delivery but USAID ran several community and key-population programs (DREAMS, CHEKUP, and ECAP III), so we exclude it from the main sample rather than assign it to the comparison group. North-Western was formally USAID-supported, but that support was limited, and the Ministry of Health's own projection of the freeze's effects (*13*) left it out. The primary results include North-Western in treatment and omit Lusaka from the analysis. For robustness, the supplementary materials report the other three combinations (sections S9.3, S9.4, and S9.5; table S10 for deaths among ART patients for all four permutations).

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Acknowledgments

We thank Ramona Godbole, Eeshani Kandpal, Charles Kenny, Megan McGuire, Harsha Thirumurthy, and Chris Udry for helpful comments and discussions. Lakshmipriya Gopikrishnan and Prasiddha Sapkota provided excellent research assistance.

Funding: The authors did not receive funding.

Author contributions: Conceptualization: T.F.W., D.K., N.M., A.R., Methodology: T.F.W., D.K., N.M., A.R., Data acquisition: T.F.W., N.M., A.R., K.Z., Data analysis: T.F.W., D.K., N.M., A.R., Visualization: T.F.W., D.K., N.M., A.R., Writing - original draft: T.F.W., D.K., N.M., A.R., Writing - review & editing: T.F.W., D.K., N.M., A.R., K.Z.

Competing interests: Figueiredo Walter, Moneke, and Radu declare no competing interests. Karlan declares no currently competing interests but was on detail from Northwestern University into USAID as the Agency Chief Economist from October 2022 until the end of February 2025 under the Intergovernmental Personnel Act. Zyambo is employed at the Zambian Ministry of Health and was the Chief HIV Clinical Mentor and ECHO Technical Lead from October 2023 until March 2025, and the Program Director HIV Prevention Program from April 2025 until present.

Data and materials availability: The data are owned by the Zambian Ministry of Health and were provided to the authors under a data-use agreement. The agreement prohibits the authors from publicly sharing or redistributing the underlying facility-level data. Researchers interested in accessing these data can apply for access through the Zambian Ministry of Health. Analysis code is available from the authors upon request.

Ethics statement: This study involved secondary analysis of existing administrative health records and did not constitute human-subjects research. No researchers interacted with patients or received personally identifiable information. Accordingly, institutional ethics review was not required.

Supplementary Materials

Supplementary Text
Figures S1 to S9
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Supplementary Materials for

Mortality Effects of the 2025 US Aid Freeze: Evidence from Zambia

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This PDF file includes:
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S1 PEPFAR

PEPFAR is a US-funded global health program created in 2003 under President George W. Bush in response to the HIV/AIDS epidemic. With a total investment of more than $100 billion since its launch, the program became dominant in US development work, encompassing for example 64% of the overall foreign aid budget in Zambia in fiscal year 2024 (October 1, 2023 to September 30, 2024). To date, PEPFAR remains the largest commitment ever made by any nation to a single disease, and has been credited with saving 26 million lives (*2–4*).

In 2024, the year prior to the US aid freeze, PEPFAR provided antiretroviral therapy (ART) to 20.6 million people across more than 50 countries, delivered HIV testing services to 83.8 million people, and provided prevention services to millions more. To effectively implement these services, PEPFAR worked with ministries of health and private contractors and directly supported 342,000 health professionals in partner countries (*3*).

For political reasons, the implementation of PEPFAR was divided between USAID and CDC at the time of program creation, with a Global AIDS Coordinator at the State Department overseeing the collaboration of the two agencies. In practice, the division followed institutional comparative advantage and country-specific operational arrangements. For example, USAID typically supported supply chain systems, while CDC supported laboratory and surveillance systems (*6*). At the same time, both agencies provided technical assistance and direct support for service delivery, but aimed to avoid duplication through specialization in separate geographies within countries (*5*). Overall, USAID managed about 65% of program funds and CDC about 35% (*2*).

S2 The fight against HIV in Zambia

HIV was first reported in Zambia in 1988. Over the following decade, prevalence rose quickly, peaking at 19% in 1998. As a result, life expectancy fell from 54 to only 37 years (*57*, *58*). In response to the epidemic, ART and HIV prevention were rolled out across the country from the early 2000s onwards and heavily subsidized by the government (*45*, *59*). In 2021 Zambia nearly achieved the "95-95-95" UNAIDS target of diagnosing more than 95% of people living with HIV, providing treatment to more than 95% of the diagnosed, and reducing the viral load of more than 95% of the treated to undetectable levels (*60*). Nonetheless, HIV prevalence remains high at 8.7% among prime-aged adults, with statistically significantly higher rates among women (11.1%) than men (5.9%) (*16*).

Since 2003, the US government has committed nearly $7 billion to HIV treatment and prevention in Zambia through PEPFAR (*61*). In 2024, the program accounted for 84% of Zambia's HIV financing and supported approximately 1.3 million Zambians with life-saving HIV medication. Beyond financial support, PEPFAR employed thousands of frontline health workers delivering HIV treatment and prevention, as well as staff supporting healthcare operations, patient outreach, clinical supervision, medication supply chains, laboratory services, and data management (*13*, *17*).

PEPFAR was implemented by USAID and CDC. While USAID supported the national supply chain, CDC provided nationwide support to laboratories and assistance with surveillance, as detailed in section S3. The provision of technical assistance and service delivery support was geographically split between the two agencies, with USAID focusing on the provinces along Zambia's northern border (Northern, Luapula, Muchinga, North-Western, Copperbelt, and Central) and CDC concentrating on the provinces along the southern border (Eastern, Lusaka, Southern, and Western), as shown in Fig. 1a.

The delivery models used by the two agencies were fundamentally different. While USAID funded international and local NGOs to provide technical assistance and directly funded facility-level clinical and support staff, CDC provided technical assistance and direct implementation support through a government-to-government model, working closely with Provincial Health Offices (*7*). In the USAID-supported provinces, PEPFAR-funded health workers played a major role. In Luapula, Copperbelt, Northern, Muchinga, and Central provinces, they provided clinical care in 70% of facilities and accounted for the majority of clinical staff in 40% of facilities, although they worked alongside government workers in all facilities (*13*). In contrast, CDC channeled service delivery support mostly through existing government structures, from Provincial Health Offices through District Health Offices to health facilities while providing strategic direction and oversight (*18*).

Several specialized initiatives did not strictly adhere to the geographic assignment of responsibilities outlined above. For example, DREAMS, PEPFAR's HIV-prevention program for adolescent girls and young women, administered by USAID not only in three of the six USAID provinces along the northern border, but also in several urban centers in CDC provinces (Chipata, Livingstone, Lusaka) (*62*, *63*). Other specialized initiatives under the Empowered Children & Adolescents Program III (ECAP III) and the Controlling HIV Epidemic for Key and Underserved Populations Projects (CHEKUP) I and II were similarly implemented by USAID in selected districts in both USAID-supported and CDC-supported provinces (*62*, *64*). Since all of these initiatives were active in Lusaka, we classify Lusaka province as an area in which both agencies, USAID and CDC, supported service delivery (see Fig. 1a).

S3 PEPFAR implementation in Zambia

S3.1 Supply chain

The national commodity supply chain was supported by USAID. Its Global Health Supply Chain Program-Procurement and Supply Management (GHSC-PSM) worked with Zambia's single national medicines agency, ZAMMSA, and its central warehouse to procure HIV/AIDS commodities for the entire country. Moreover, it provided forecasting and supply planning (FASP) technical support to the Ministry of Health and logistics support to ZAMMSA through its electronic logistics system eSCMIS (*65*, *66*).

S3.2 Laboratories and surveillance

The CDC supported national laboratory systems by helping build diagnostic testing capacity for 24 viral load laboratories, over 250 point-of-care testing platforms, and 200+ hub facilities. Moreover, it assisted with the implementation of the SmartCare National Electronic Health Record system in more than 1,600 high-volume health facilities across Zambia with more than 2 million people enrolled (*67*).

S3.3 DREAMS program

The HIV-prevention program for adolescent girls and young women entitled DREAMS was implemented through both USAID and CDC, but the implementation did not respect the geographic split governing service delivery support. USAID ran DREAMS in 11 districts through CHEKUP I and CHEKUP II. CHEKUP I, implemented by CIDRZ and funded by USAID, ran in seven districts: Chingola, Kitwe, Livingstone, Luanshya, Lusaka, Mufulira, and Ndola (*63*). CHEKUP II, implemented by John Snow Health (JSH), staffed DREAMS centers in four districts: Chipata, Kabwe, Kapiri Mposhi, and Kasama (*62*). At the same time, CDC ran DREAMS in Mazabuka, Monze, and Mongu through the University of Maryland, Baltimore (*68*).

S4 The USAID shutdown

On inauguration day, January 20, 2025, President Trump issued an executive order to freeze foreign aid pending a review, and stop-work orders immediately ensued. As a result, all PEPFAR support to Zambian health facilities, whether administered through USAID or CDC, was halted (*7*). Twelve days later, on February 1, a waiver exempting life-saving humanitarian aid allowed PEPFAR to resume. Many HIV prevention activities were not included, however, including pre-exposure prophylaxis (PrEP) that was not aimed at preventing mother-to-child transmission (*8*). While other services restarted soon after in CDC-supported provinces, almost all USAID staff were put on leave in early February. Therefore, the waiver either did not reach contractors or they faced insurmountable administrative hurdles to authorize the reopening of services (*8–10*). Therefore, despite the waiver, the uncertainty and inconsistency in its application led many USAID-funded activities to remain disrupted until PEPFAR functions were taken over by the State Department later in 2025 (*11*, *12*).

Thus the dismantling of USAID heavily affected the implementation of PEPFAR across Zambia for several months in 2025. According to the Ministry of Health, 24,000 health workers were put under stop-work instructions. The national HIV commodity supply chain stalled as forecasting, procurement, and last-mile deliveries were halted, and the national sample-courier system collapsed when the implementing partners withdrew the fuel, riders, and laboratory personnel at central labs (*13*, *14*).

At the facility level, this disruption led to severe staff shortages, limiting service delivery especially in USAID-supported provinces. To cope with the mounting pressures on the health system, facilities rationed antiretrovirals (ARVs), reducing multi-month dispensing from six to three months, and redeployed personnel from other departments to support ART services, often without adequate ART-specific training (*10*, *15*). At the national level, the Ministry of Health prioritized the continuity of essential HIV services and initiated the integration of previously USAID-supported services into the government health system, including the absorption of PEPFAR-funded health workers into the public health workforce (*13*, *14*).

S5 Data

All health facilities in Zambia, including private ones, are required to submit monthly records on health service utilization and notifiable diseases to the Ministry of Health via the Health Management Information System (*69*). As a result, the HMIS database captures the universe of health facilities operating in Zambia. We verify this by comparing the number of facilities contained in our sample against the total number of facilities included in the Master Facility List (MFL) of the Ministry of Health (*70*) and the 2024 Listing of Health Facilities by the Health Professions Council of Zambia (*71*). Excluding Lusaka province, our sample contains a total of 3,294 facilities while the MFL features 3,296 facilities and the Health Professions Council listing features 3,381 facilities.

We use administrative microdata from the Zambian Health Management Information System to track service delivery and health outcomes from month to month across the universe of Zambian health facilities. Our main analysis sample (excluding Lusaka province) is composed of 3,294 facilities. Of these, 95% are publicly owned and 78% are in rural areas. Hospitals account for 5% of facilities, while the remaining 95% are divided approximately equally between health centers and health posts. The average facility in our sample saw 657 outpatients per month in the 15 months before the shutdown, had a total of 289 patients on ART, and conducted 124 HIV tests.

Reassuringly, facilities in the USAID and CDC subsets of provinces were observationally similar prior to the US aid freeze. The USAID- and CDC-supported provinces had similar shares of facility types and ownership (table S1), and similar service delivery and health outcomes over the 15 months before the freeze from November 2023 to January 2025 (shown in Fig. 1b and in more detail in table S2, with an aggregate test failing to reject equality of means with p-value = 0.50). None of the 16 outcomes rejected equality when tested individually.

S6 Summary statistics

Table S1. Pre-freeze summary statistics – Health facilities

	Full sample	Treatment USAID	Comparison CDC	Difference	*p*-value
Number of facilities	3,294	1,999	1,295	704	
Facility type					
Health post	0.48	0.47	0.49	−0.01	0.75
	(0.50)	(0.50)	(0.50)		
Health center	0.46	0.45	0.46	−0.01	0.81
	(0.50)	(0.50)	(0.50)		
Hospital (1st, 2nd or 3rd level)	0.05	0.05	0.04	0.01	0.36
	(0.22)	(0.22)	(0.20)		
Other	0.02	0.02	0.01	0.01	0.07
	(0.13)	(0.15)	(0.10)		
Location					
Urban	0.22	0.25	0.17	0.09	0.22
	(0.41)	(0.44)	(0.37)		
Rural	0.78	0.75	0.83	−0.09	0.22
	(0.41)	(0.44)	(0.37)		
Ownership					
Public	0.95	0.94	0.98	−0.04	0.27
	(0.21)	(0.24)	(0.16)		
Private	0.05	0.06	0.02	0.04	0.27
	(0.21)	(0.24)	(0.16)		

All facilities in the nine provinces of the main analysis sample (six USAID, three CDC). Standard deviations in parentheses. *p*-value: regression on the treatment dummy, with standard errors clustered by province. Other: general, dental and eye clinics, diagnostic and rehabilitation centers, hospices, first-aid stations, and a few facilities of unknown type. Location: rural if the facility's name contains *Rural* or *Health Post*, urban otherwise.

Table S2. Pre-freeze summary statistics – Health services and health outcomes

	Full sample	Treatment USAID	Comparison CDC	Difference	*p*-value
HIV tests	123.95	131.29	112.61	18.69	0.29
	(172.53)	(195.62)	(128.26)		
PrEP initiations	5.38	5.42	5.32	0.09	0.96
	(13.54)	(15.42)	(9.97)		
CHA community meetings	4.78	5.52	3.63	1.89	0.34
	(29.97)	(35.87)	(17.22)		
Patients receiving ART	288.70	291.37	284.58	6.79	0.94
	(625.53)	(653.41)	(580.09)		
ART patients lost to follow-up	2.25	2.93	1.21	1.72	0.11
	(8.70)	(10.60)	(4.14)		
ART pickups one month late	3.40	4.33	1.96	2.37	0.21
	(34.89)	(42.85)	(16.10)		
HIV-positive pregnant women at ANC	0.80	0.80	0.80	0.00	0.99
	(1.67)	(1.77)	(1.51)		
HIV-exposed live births	0.70	0.72	0.67	0.05	0.83
	(2.90)	(2.99)	(2.76)		
ART starts with advanced HIV	0.09	0.09	0.10	0.00	0.96
	(0.45)	(0.49)	(0.37)		
Tuberculosis	0.46	0.57	0.30	0.26	0.11
	(1.81)	(2.11)	(1.16)		
Meningitis	0.03	0.03	0.03	0.00	0.76
	(0.25)	(0.25)	(0.25)		
Deaths among ART patients	0.16	0.18	0.14	0.04	0.39
	(0.35)	(0.39)	(0.27)		
Outpatient contacts	656.97	667.11	641.32	25.79	0.84
	(750.00)	(830.38)	(605.28)		
Inpatient admissions	18.65	18.94	18.20	0.74	0.88
	(105.94)	(101.45)	(112.55)		
Penta-3 vaccinations	15.57	16.23	14.54	1.69	0.40
	(18.11)	(20.06)	(14.55)		
Road traffic accidents	1.27	1.51	0.90	0.61	0.23
	(5.37)	(5.91)	(4.38)		
Joint test of the 16 outcomes: $F = 8.68$					0.50

All facilities in the nine provinces of the main analysis sample (six USAID, three CDC). Standard deviations in parentheses. *p*-value: regression on the treatment dummy, wild cluster bootstrap by province (Webb weights, 9,999 replications, null imposed; boottest). Joint test: the F-statistic of an OLS regression of the treatment dummy on the 16 outcomes; its p-value is from randomization inference (RI) over the provinces, not from the F distribution: every way to make 6 of the 9 provinces treated is a possible assignment (84, the actual one among them); the p-value is the share of them with an F at least as large as the actual one (smallest possible value 1/84 = 0.01). Outcomes: the raw outcome (zero in a month the facility does not report it, not winsorized), its monthly average over November 2023-January 2025 (the 15 pre-period months of the main specification), per facility.

S7 Materials and methods: empirical strategy

We compare the change in service delivery indicators and health outcomes across health facilities in USAID-supported and CDC-supported provinces following the US aid freeze. We treat February as the first post-freeze period since the initial stop-work order on January 20 brought all activities of both USAID and CDC to a halt, but the waiver that followed on February 1 allowed CDC to resume activities quickly while USAID activities remained largely suspended. The full regression specification follows below.

This comparison captures the differential change in outcomes between the two subsets of provinces, but likely underestimates the full extent of the disruption to the health system and the ensuing consequences for two reasons. First, service delivery in CDC-supported provinces was indirectly affected by the dismantling of USAID because CDC-supported facilities relied on the national HIV commodity supply chain and courier system managed by USAID and thus vulnerable to the extended disruption of USAID-funded activities. In line with this, Saito *et al.* (*30*) reports statistically significant reductions in testing and ART initiations in a convenience sample of 48 CDC-supported health facilities in Zambia between October 2024 and March 2025. Second, the exclusion of many prevention activities from the waiver, most importantly PrEP, limited the resumption of these activities not only in USAID-supported provinces, but also in CDC-supported provinces.

Our main regression specification is:

$$Y_{ib} = \alpha_i + \lambda_b + \sum_{k=-5, k\neq -1}^{4} \theta_k \mathbf{1}[b = k] D_i + \varepsilon_{ib}, \tag{1}$$

where Y_{ib} is the monthly average of the outcome in facility i over block b, α_i and λ_b are facility and block fixed effects, and D_i equals one if facility i is located in a USAID-supported province. The coefficients θ_k measure the difference between USAID- and CDC-supported provinces in block k relative to the reference block, November 2024-January 2025 ($k = -1$), the last three months before the freeze. The pre-period coefficients $\theta_{-5}, \ldots, \theta_{-2}$ show whether the two groups of provinces evolved in parallel before the freeze. The tables report averages of these coefficients over the three post-freeze periods: $\beta_1 = \theta_0$ (February-April 2025), $\beta_2 = (\theta_1 + \theta_2)/2$ (May-October 2025) and $\beta_3 = (\theta_3 + \theta_4)/2$ (November 2025-April 2026), each multiplied by the number of USAID-supported facilities (1,999) so that it is the total change per month across the treated facilities. For ART pickups one month late and ART starts with advanced HIV, whose data end in December 2025, $\beta_3 = \theta_3$ and covers November-December 2025 only.

S8 Main results

Table S3. Three-month blocks of the raw outcome, windows 3/6/6, wild cluster bootstrap; Lusaka dropped; treatment from February 2025; 15 pre-period months, from November 2023; all facilities

Outcome	β_1 Feb-Apr 25	β_2 May-Oct 25	β_3 Nov 25-Apr 26	Mean Nov 24-Jan 25	Pre-period p	R^2
1. HIV prevention						
HIV tests	−57,668**	−4,037	−7,330	256,732	0.79	0.84
	[−96,511, −7,618]	[−58,029, 39,993]	[−48,541, 29,181]			
PrEP initiations	−3,804**	−942	−460	8,743	0.33	0.52
	[−7,377, −186]	[−3,670, 1,803]	[−3,849, 2,947]			
CHA community meetings	−1,178	−3,809**	−3,223*	6,299	0.61	0.40
	[−3,833, 2,375]	[−6,864, −40]	[−5,999, 363]			
2. HIV treatment						
Patients receiving ART	−16,186*	−12,206	−11,518	590,946	0.52	0.99
	[−37,254, 4,830]	[−64,328, 35,741]	[−72,387, 46,096]			
ART patients lost to follow-up	3,124**	3,553*	797	5,883	0.23	0.61
	[380, 5,893]	[−392, 7,502]	[−1,159, 2,768]			
ART pickups one month late	4,945**	5,194**	3,783**	8,644	0.56	0.67
	[497, 9,973]	[1,306, 9,225]	[1,116, 6,585]			
3. HIV infections						
HIV-positive pregnant women at ANC	44	166	223**	1,600	0.20	0.77
	[−255, 288]	[−98, 442]	[41, 406]			
HIV-exposed live births	81	227**	164	1,531	0.16	0.88
	[−178, 285]	[22, 382]	[−181, 474]			
ART starts with advanced HIV	32	72	113*	176	0.50	0.46
	[−49, 115]	[−34, 183]	[−19, 246]			
4. Opportunistic infections and death						
Tuberculosis	−192	26	234**	1,120	0.41	0.85
	[−523, 149]	[−182, 250]	[69, 446]			
Meningitis	32**	27***	44**	37	0.50	0.54
	[0, 62]	[17, 37]	[12, 74]			
Deaths among ART patients	−65*	56	81**	310	0.15	0.45
	[−129, 4]	[−40, 148]	[24, 139]			
5. Externalities						
Outpatient contacts	−279,077*	−219,692	−33,024	1,338,749	0.05	0.68
	[−539,115, 30,872]	[−525,342, 143,376]	[−160,357, 98,738]			
Inpatient admissions	−6,518	−9,272**	−4,604	37,421	0.15	0.84
	[−16,621, 2,885]	[−18,449, −500]	[−12,298, 2,946]			

All facilities in the nine provinces of the main analysis sample (six USAID, three CDC), November 2023 to the outcome's last month; 3,294 facilities, one observation per facility and block, 10 blocks (9 for ART pickups one month late and ART starts with advanced HIV). Outcome: the raw outcome (zero in a month the facility does not report it, not winsorized), averaged over three-month blocks. β_1, β_2 and β_3 average the event-study coefficients over the blocks in February-April 2025, May-October 2025 and November 2025-April 2026, relative to the reference block, November 2024-January 2025. ART pickups one month late and ART starts with advanced HIV end in December 2025, so their β_3 covers November-December 2025 only. Event study with facility and block fixed effects. Coefficients, confidence intervals and Mean are totals per month over the 1,999 treated facilities (per-facility values times 1,999); Mean is the monthly average over November 2024-January 2025. Pre-period p: wild cluster bootstrap p-value of the joint test that the 4 event-study coefficients before the reference block (from November 2023) are all zero. Inference: wild cluster bootstrap by province (9 clusters; Webb weights, 9,999 replications, null imposed); 95% confidence intervals in brackets, from inverting the bootstrap test; stars from bootstrap p-values, * p<0.10, ** p<0.05, *** p<0.01.

Table S4. The effects of Figure 3 with their 95% confidence intervals

Outcome	Period 1 Feb 2025-Apr 2025	Period 2 May 2025-Oct 2025	Period 3 Nov 2025-Apr 2026
Prevention			
HIV tests	−22 [−38, −3]	−2 [−23, 16]	−3 [−19, 11]
PrEP initiations	−44 [−84, −2]	−11 [−42, 21]	−5 [−44, 34]
CHA community meetings	−19 [−61, 38]	−60 [−109, −1]	−51 [−95, 6]
Treatment			
Patients receiving ART	−3 [−6, 1]	−2 [−11, 6]	−2 [−12, 8]
ART patients lost to follow-up	53 [6, 100]	60 [−7, 128]	14 [−20, 47]
ART pickups one month late	57 [6, 115]	60 [15, 107]	44 [13, 76]
HIV infections			
HIV-positive pregnant women at ANC	3 [−16, 18]	10 [−6, 28]	14 [3, 25]
HIV-exposed live births	5 [−12, 19]	15 [1, 25]	11 [−12, 31]
ART starts with advanced HIV	18 [−28, 65]	41 [−20, 104]	64 [−11, 139]
Opportunistic infections and death			
Tuberculosis	−17 [−47, 13]	2 [−16, 22]	21 [6, 40]
Meningitis	87 [1, 168]	73 [45, 101]	118 [34, 199]
Deaths among ART patients	−21 [−41, 1]	18 [−13, 48]	26 [8, 45]

All facilities in the nine provinces of the main analysis sample (six USAID, three CDC). Each cell: the effect in Figure 3, β_j of the main specification (Table S3) divided by the outcome's Mean column there (its monthly average over November 2024-January 2025, the reference block, summed over the treated facilities), in percent, and in brackets its 95% confidence interval, the table's wild cluster bootstrap interval (9 province clusters) divided by the same mean; the mean is taken as given. ART pickups one month late and ART starts with advanced HIV end in December 2025, so their period 3 covers November 2025 to December 2025 only.

S9 Robustness of main results

Pre-shutdown balance. We provide evidence supporting the orthogonality of USAID vs. CDC provinces to key pre-shutdown outcomes. Testing for the joint statistical significance of pre-treatment coefficients, we fail to reject the null hypothesis for each of the 12 HIV outcomes; for outpatient contacts the p-value is 0.05) (table S3).

Reporting. Data entry and management of the government's HMIS were potentially also affected by the USAID shutdown. In particular, our results on negative differential impacts on HIV testing, PrEP, and other variables may be capturing the combined effect of differentially worse reporting in USAID provinces and differential health impacts due to lower service delivery. This scenario may imply that we are overestimating some of the disruption caused by the shutdown. Two pieces of evidence can help alleviate this concern. First, several outcomes differentially increase rather than decrease in USAID provinces, most prominently the number of ART patients who are lost to follow-up (LTFU). (*72*) Second, we find no negative impact on the delivery of near-universal health services of high priority, such as Penta-3 vaccinations administered to infants under twelve months. Unrelated health issues, such as the number of road accidents, also do not display any differential reporting post-shutdown (section S9.2).

Sample composition, aggregation, and alternative data sources. We demonstrate that results are robust to changes in the underlying sample of health facilities, such as the inclusion of Lusaka province in the comparison group (section S9.3) and the restriction of the sample to a balanced panel (section S9.7), as well as the use of disaggregated, de-seasonalized monthly data (section S9.8). Additionally, we show similar reductions in HIV testing and PrEP initiations as documented above in alternative data from the PEPFAR-Monitoring, Evaluation and Reporting system (section S9.9).

S9.1 Differential non-reporting

The freeze and the staffing shortages that ensued may have caused differential lapses in reporting between USAID and CDC provinces. In the data, non-reports are recorded as zero, so we cannot directly distinguish a true zero from a non-report. We address this in two ways.

First, we can observe whether an entire section of data is reported as zero, and infer that the section was more likely not reported than truly zero. We note that in the analysis of treatment effects, dropping non-reports is not necessarily the right corrective action. If non-reports are then later reported as part of a future time period, which is standard practice, then trimming the data to drop non-reports would lead to an overestimate of totals, whereas keeping the non-reports as zero leads to an unbiased estimate (although an overestimate of the variance).

Second, the placebo test in the next section also sheds light on this potential non-reporting issue.

Table S5. Reporting a major form section (percent of months), three-month blocks, windows 3/6/6, wild cluster bootstrap; Lusaka dropped; treatment from February 2025; 15 pre-period months, from November 2023; all facilities

Outcome	β_1 Feb-Apr 25	β_2 May-Oct 25	β_3 Nov 25-Apr 26	Mean Nov 24-Jan 25	Pre-period p	R^2
Major sections of the HIA2 form						
Section 1: child health (1.1-1.3)	0.63	0.59	1.90*	85.88	0.73	0.84
	[−1.32, 2.54]	[−1.33, 2.57]	[−0.52, 4.36]			
Section 3: maternal health (3.1-3.5)	0.16	0.78	1.37	90.06	0.43	0.80
	[−1.35, 1.72]	[−1.32, 2.76]	[−0.98, 3.67]			
Section 4: HIV (4.1-4.6)	0.21	0.44	1.82	89.61	0.10	0.81
	[−1.45, 1.86]	[−1.25, 2.16]	[−0.59, 4.29]			
Section 5: malaria (5.1)	−1.48	−0.37	0.25	91.06	0.81	0.76
	[−4.30, 0.97]	[−2.49, 1.87]	[−1.70, 2.17]			
Section 6: OPD and IPD (6.1-6.4)	−0.14	0.39	1.33	88.71	0.96	0.71
	[−1.75, 1.50]	[−1.57, 2.64]	[−0.57, 3.37]			
Any of sections 1 and 3-6	0.04	0.27	0.85	92.65	0.94	0.79
	[−1.12, 1.27]	[−1.14, 1.68]	[−1.14, 3.26]			

All facilities in the nine provinces of the main analysis sample (six USAID, three CDC), November 2023 to the outcome's last month; 3,294 facilities, one observation per facility and block, 10 blocks. Outcome: 100 if the facility reports any item of any sub-section of the section in the month, 0 if it reports none, averaged over three-month blocks, so the percentage of the block's months in which the section is reported; effects are in percentage points. Any = any of the five sections. β_1, β_2 and β_3 average the event-study coefficients over the blocks in February-April 2025, May-October 2025 and November 2025-April 2026, relative to the reference block, November 2024-January 2025. Event study with facility and block fixed effects. Mean: mean of the outcome over treated facilities in November 2024-January 2025, the reference block. Pre-period p: wild cluster bootstrap p-value of the joint test that the 4 event-study coefficients before the reference block (from November 2023) are all zero. Inference: wild cluster bootstrap by province (9 clusters; Webb weights, 9,999 replications, null imposed); 95% confidence intervals in brackets, from inverting the bootstrap test; stars from bootstrap p-values, * p<0.10, ** p<0.05, *** p<0.01.

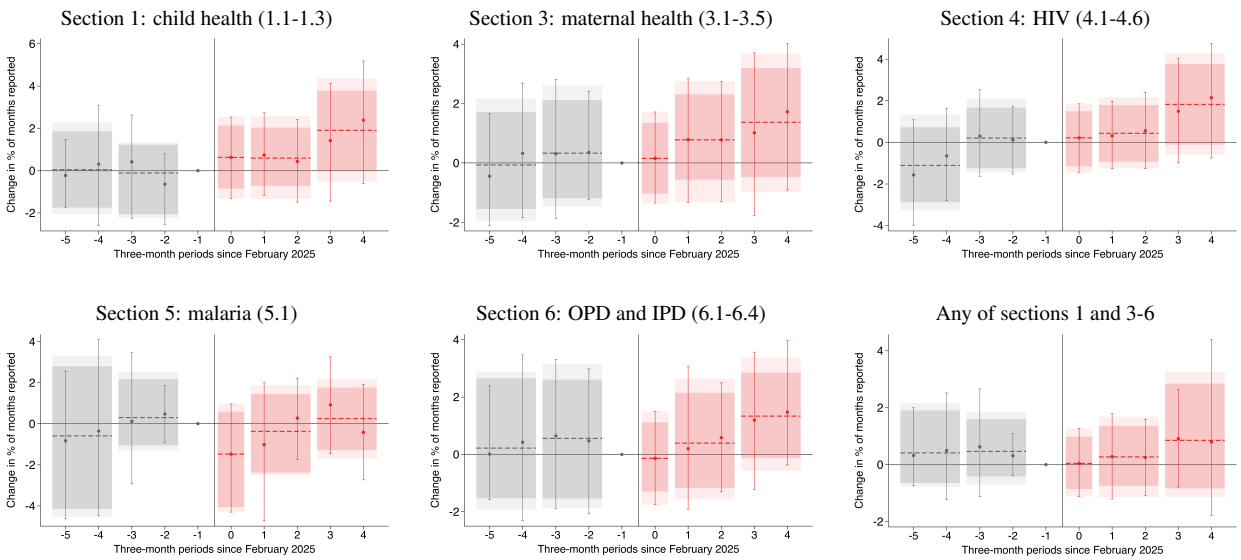


Fig. S1. Event studies with window averages, all facilities: Reporting a major form section (percent of months), three-month blocks, windows 3/6/6, wild cluster bootstrap; Lusaka dropped; treatment from February 2025; 15 pre-period months, from November 2023; three-month periods

Dots: event-study coefficients with 95% intervals, before (gray) and after (red) the first treated period; the reference period, the one before it, is the gray dot at zero (no interval). Boxes: the mean coefficient of each window (dashed line), computed with lincom, with its 90% (darker) and 95% (lighter) interval; after February 2025 these are β_1, β_2 and β_3 of Table S5, before it windows of the same kind. Effects are per facility. Intervals from the wild cluster bootstrap by province (Webb weights, 9,999 replications, null imposed; boottest), by inverting the bootstrap test, as in the table; the periods' fixed effects enter as dummies. Outcome: 100 if the facility reports any item of any sub-section of the section in the month, 0 if not; effects are in percentage points of the months reported.

S9.2 Placebo

We conduct event study analyses on placebo outcomes for two purposes. The first is to shed light on the potential non-reporting issue. By examining treatment effects on placebo outcomes that should not react to the shutdown, such as near-universal Penta-3 vaccinations for children under twelve months and road accidents, we can observe whether non-reporting is leading to the appearance of treatment effects. If anything, the treatment effects push against such a mechanism.

The second purpose of studying event studies for the two placebo outcomes is to test our empirical strategy of using CDC-supported provinces as a comparison group for USAID-supported provinces. We find no statistically significant pre- or post-freeze differences between USAID and CDC provinces on the two outcomes, Penta-3 vaccinations and road accidents, that were unlikely to have been affected by the USAID shutdown.

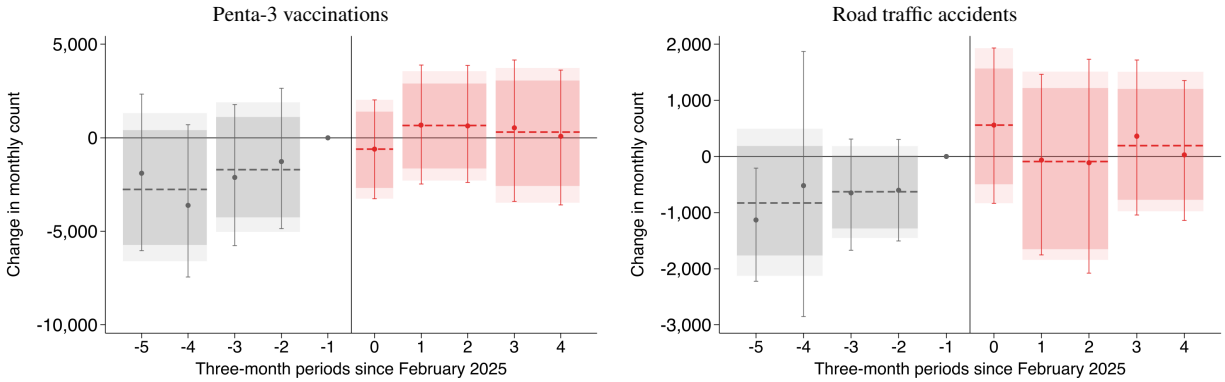


Fig. S2. Event studies with window averages, all facilities: Placebo outcomes: three-month blocks of the raw outcome, windows 3/6/6, wild cluster bootstrap; Lusaka dropped; treatment from February 2025; 15 pre-period months, from November 2023; three-month periods

Dots: event-study coefficients with 95% intervals, before (gray) and after (red) the first treated period; the reference period, the one before it, is the gray dot at zero (no interval). Boxes: the mean coefficient of each window (dashed line), computed with lincom, with its 90% (darker) and 95% (lighter) interval; after February 2025 these are β_1, β_2 and β_3 of Table S6, before it windows of the same kind. Effects are changes in the monthly count, summed over the treated facilities. Intervals from the wild cluster bootstrap by province (Webb weights, 9,999 replications, null imposed; boottest), by inverting the bootstrap test, as in the table; the periods' fixed effects enter as dummies. Outcomes: the raw outcome (zero in a month the facility does not report it, not winsorized), averaged over three-month blocks, as in Table S3.

Table S6. Placebo outcomes: three-month blocks of the raw outcome, windows 3/6/6, wild cluster bootstrap; Lusaka dropped; treatment from February 2025; 15 pre-period months, from November 2023; all facilities

Outcome	β_1 Feb-Apr 25	β_2 May-Oct 25	β_3 Nov 25-Apr 26	Mean Nov 24-Jan 25	Pre-period p	R^2
Placebo						
Penta-3 vaccinations	−606	655	304	34,443	0.57	0.85
	[−3,254, 2,025]	[−2,290, 3,557]	[−3,472, 3,731]			
Road traffic accidents	559	−89	195	3,459	0.45	0.42
	[−833, 1,929]	[−1,842, 1,512]	[−976, 1,508]			

All facilities in the nine provinces of the main analysis sample (six USAID, three CDC), November 2023 to the outcome's last month; 3,294 facilities, one observation per facility and block, 10 blocks. Outcomes: the raw outcome (zero in a month the facility does not report it, not winsorized), averaged over three-month blocks, as in Table S3. β_1, β_2 and β_3 average the event-study coefficients over the blocks in February-April 2025, May-October 2025 and November 2025-April 2026, relative to the reference block, November 2024-January 2025. Event study with facility and block fixed effects. Coefficients, confidence intervals and Mean are totals per month over the 1,999 treated facilities (per-facility values times 1,999); Mean is the monthly average over November 2024-January 2025. Pre-period p: wild cluster bootstrap p-value of the joint test that the 4 event-study coefficients before the reference block (from November 2023) are all zero. Inference: wild cluster bootstrap by province (9 clusters; Webb weights, 9,999 replications, null imposed); 95% confidence intervals in brackets, from inverting the bootstrap test; stars from bootstrap p-values, * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

S9.3 Lusaka included in comparison group

Facility-level service delivery in Lusaka province was supported by CDC, but at the same time USAID was responsible for multiple community and key population programs in the capital. This impedes an unambiguous attribution of the province to the comparison group. Below, we show that our main results are robust to including Lusaka in the comparison group.

Table S7. Three-month blocks of the raw outcome, windows 3/6/6, wild cluster bootstrap; Lusaka in the comparison group; treatment from February 2025; 15 pre-period months, from November 2023; all facilities

Outcome	β_1 Feb-Apr 25	β_2 May-Oct 25	β_3 Nov 25-Apr 26	Mean Nov 24-Jan 25	Pre-period p	R^2
1. HIV prevention						
HIV tests	−46,268*	−2,258	−1,740	256,732	0.66	0.88
	[−87,944, 7,864]	[−47,489, 36,721]	[−40,790, 34,456]			
PrEP initiations	−2,836	−278	348	8,743	0.44	0.50
	[−6,508, 1,628]	[−3,003, 2,915]	[−3,078, 4,132]			
CHA community meetings	−2,360	−3,223*	−2,953*	6,299	0.63	0.39
	[−6,776, 1,385]	[−6,264, 398]	[−5,555, 178]			
2. HIV treatment						
Patients receiving ART	−16,852**	14,864	12,317	590,946	0.31	0.99
	[−36,310, −1,299]	[−50,225, 123,964]	[−55,083, 112,278]			
ART patients lost to follow-up	3,348**	4,250**	1,216	5,883	0.75	0.59
	[789, 6,022]	[914, 8,371]	[−690, 3,350]			
ART pickups one month late	9,109**	9,272**	8,032**	8,644	0.38	0.48
	[784, 25,640]	[1,590, 25,708]	[944, 24,924]			
3. HIV infections						
HIV-positive pregnant women at ANC	59	222*	342***	1,600	0.13	0.86
	[−204, 260]	[−35, 510]	[84, 812]			
HIV-exposed live births	−31	105	176	1,531	0.13	0.92
	[−464, 259]	[−369, 366]	[−102, 437]			
ART starts with advanced HIV	20	62	129**	176	0.44	0.46
	[−61, 103]	[−35, 164]	[9, 259]			
4. Opportunistic infections and death						
Tuberculosis	−124	−8	203**	1,120	0.27	0.90
	[−450, 240]	[−215, 204]	[39, 400]			
Meningitis	14	−20	16	37	0.34	0.40
	[−57, 55]	[−207, 51]	[−94, 68]			
Deaths among ART patients	−42	73*	108***	310	0.07	0.46
	[−118, 47]	[−17, 162]	[34, 215]			
5. Externalities						
Outpatient contacts	−227,235	−217,872	2,252	1,338,749	0.11	0.75
	[−501,018, 56,774]	[−474,435, 78,337]	[−132,377, 155,983]			
Inpatient admissions	−2,927	−6,446	−287	37,421	0.38	0.83
	[−14,170, 11,963]	[−16,109, 5,565]	[−10,895, 16,975]			

All facilities in the nine provinces of the main analysis sample plus Lusaka (10 provinces: six USAID, four CDC), November 2023 to the outcome's last month; 3,570 facilities, one observation per facility and block, 10 blocks (9 for ART pickups one month late and ART starts with advanced HIV). Outcome: the raw outcome (zero in a month the facility does not report it, not winsorized), averaged over three-month blocks. β_1, β_2 and β_3 average the event-study coefficients over the blocks in February-April 2025, May-October 2025 and November 2025-April 2026, relative to the reference block, November 2024-January 2025. ART pickups one month late and ART starts with advanced HIV end in December 2025, so their β_3 covers November-December 2025 only. Event study with facility and block fixed effects. Coefficients, confidence intervals and Mean are totals per month over the 1,999 treated facilities (per-facility values times 1,999); Mean is the monthly average over November 2024-January 2025. Pre-period *p*: wild cluster bootstrap p-value of the joint test that the 4 event-study coefficients before the reference block (from November 2023) are all zero. Inference: wild cluster bootstrap by province (10 clusters; Webb weights, 9,999 replications, null imposed); 95% confidence intervals in brackets, from inverting the bootstrap test; stars from bootstrap p-values, * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

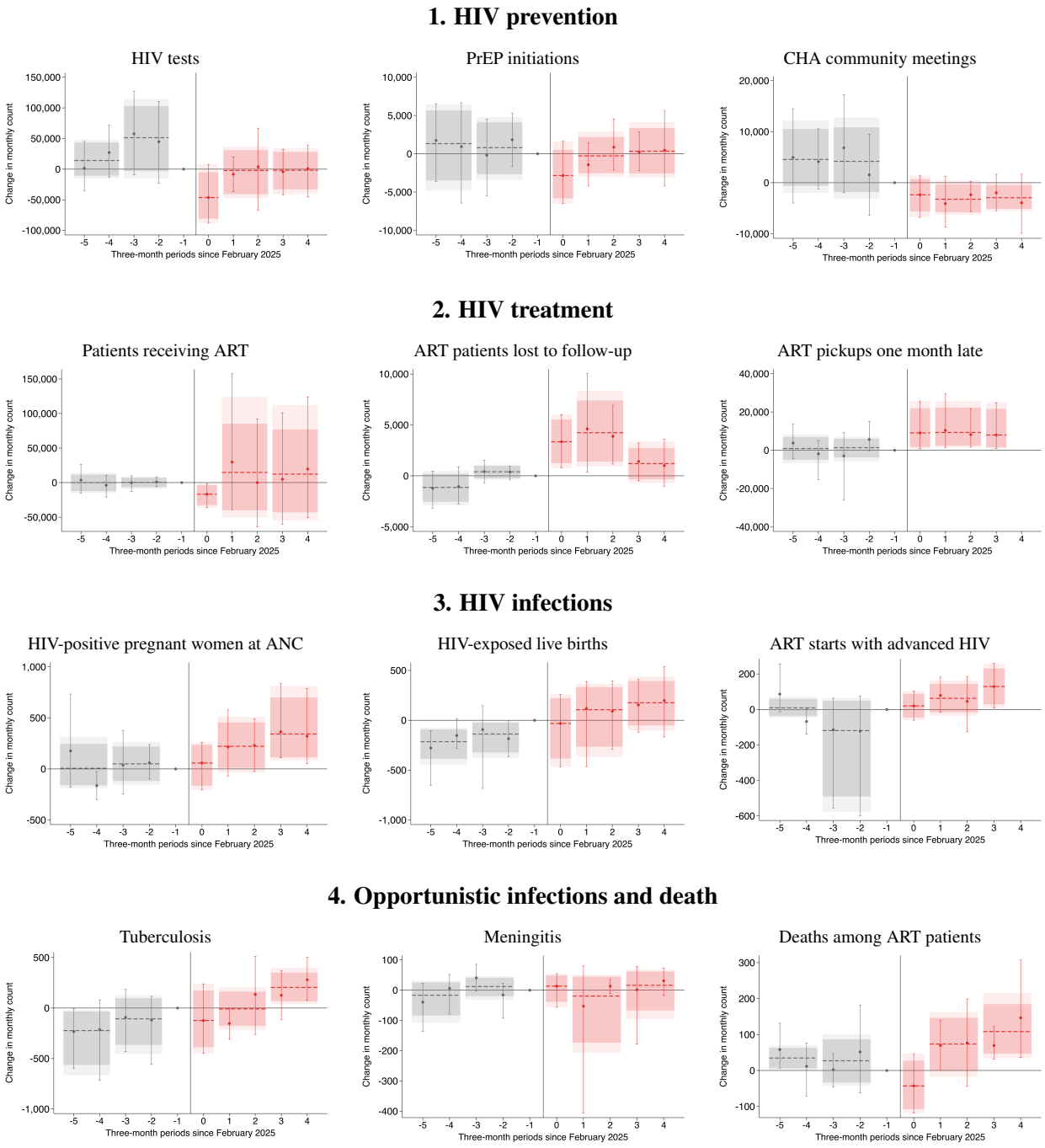


Fig. S3. Event studies with window averages, all facilities: Three-month blocks of the raw outcome, windows 3/6/6, wild cluster bootstrap; Lusaka in the comparison group; treatment from February 2025; 15 pre-period months, from November 2023; three-month periods

Dots: event-study coefficients with 95% intervals, before (gray) and after (red) the first treated period; the reference period, the one before it, is the gray dot at zero (no interval). Boxes: the mean coefficient of each window (dashed line), computed with lincom, with its 90% (darker) and 95% (lighter) interval; after February 2025 these are β_1, β_2 and β_3 of Table S7, before it windows of the same kind. Effects are changes in the monthly count, summed over the treated facilities. Intervals from the wild cluster bootstrap by province (Webb weights, 9,999 replications, null imposed; boottest), by inverting the bootstrap test, as in the table; the periods' fixed effects enter as dummies.

S9.4 North-Western excluded from treatment group

Service delivery in North-Western province was formally supported by USAID, but the level of support was very limited. In line with this, studies evaluating the effects of the USAID shutdown such as Mulenga *et al.* (*13*) did not include facilities in North-Western province. Below, we show that our main results are robust to excluding North-Western province from the treatment group.

Table S8. Three-month blocks of the raw outcome, windows 3/6/6, wild cluster bootstrap, North-Western dropped; Lusaka dropped; treatment from February 2025; 15 pre-period months, from November 2023; all facilities

Outcome	β_1 Feb-Apr 25	β_2 May-Oct 25	β_3 Nov 25-Apr 26	Mean Nov 24-Jan 25	Pre-period p	R^2
1. HIV prevention						
HIV tests	−52,935**	−9,961	−14,673	228,437	0.89	0.85
	[−84,902, −9,367]	[−52,579, 25,389]	[−44,345, 6,554]			
PrEP initiations	−3,880**	−1,186	−1,134	8,265	0.63	0.53
	[−6,244, −1,222]	[−3,498, 1,274]	[−3,316, 1,202]			
CHA community meetings	−1,051	−2,422*	−2,103	5,399	0.38	0.40
	[−3,508, 2,400]	[−4,650, 539]	[−4,239, 596]			
2. HIV treatment						
Patients receiving ART	−16,466*	−15,200	−17,638	548,237	0.68	0.99
	[−34,212, 71]	[−62,540, 27,095]	[−70,857, 30,358]			
ART patients lost to follow-up	3,220**	3,596**	1,236***	4,935	0.32	0.62
	[1,243, 5,108]	[592, 6,808]	[641, 1,826]			
ART pickups one month late	4,397**	4,459**	3,444**	7,883	0.78	0.67
	[108, 8,831]	[581, 8,050]	[1,068, 6,042]			
3. HIV infections						
HIV-positive pregnant women at ANC	16	136	149**	1,483	0.08	0.77
	[−231, 214]	[−126, 394]	[11, 296]			
HIV-exposed live births	55	177*	104	1,437	0.03	0.89
	[−163, 231]	[−14, 322]	[−184, 360]			
ART starts with advanced HIV	34	60	69	149	0.67	0.48
	[−39, 116]	[−46, 170]	[−37, 182]			
4. Opportunistic infections and death						
Tuberculosis	−157	59	225***	997	0.38	0.84
	[−473, 172]	[−102, 266]	[111, 390]			
Meningitis	30**	25***	41**	33	0.16	0.57
	[1, 55]	[17, 32]	[14, 65]			
Deaths among ART patients	−54*	57	79***	281	0.37	0.45
	[−112, 9]	[−23, 131]	[42, 119]			
5. Externalities						
Outpatient contacts	−233,576*	−153,832	−12,808	1,075,159	0.10	0.66
	[−484,766, 40,679]	[−410,742, 145,874]	[−137,117, 96,946]			
Inpatient admissions	−2,571	−5,277*	−1,758	29,657	0.30	0.88
	[−7,347, 1,023]	[−10,451, 363]	[−5,531, 2,589]			

All facilities in the eight provinces of the main analysis sample other than North-Western (five USAID, three CDC), November 2023 to the outcome's last month; 2,935 facilities, one observation per facility and block, 10 blocks (9 for ART pickups one month late and ART starts with advanced HIV). Outcome: the raw outcome (zero in a month the facility does not report it, not winsorized), averaged over three-month blocks. β_1, β_2 and β_3 average the event-study coefficients over the blocks in February-April 2025, May-October 2025 and November 2025-April 2026, relative to the reference block, November 2024-January 2025. ART pickups one month late and ART starts with advanced HIV end in December 2025, so their β_3 covers November-December 2025 only. Event study with facility and block fixed effects. Coefficients, confidence intervals and Mean are totals per month over the 1,640 treated facilities (per-facility values times 1,640); Mean is the monthly average over November 2024-January 2025. Pre-period *p*: wild cluster bootstrap p-value of the joint test that the 4 event-study coefficients before the reference block (from November 2023) are all zero. Inference: wild cluster bootstrap by province (8 clusters; Webb weights, 9,999 replications, null imposed); 95% confidence intervals in brackets, from inverting the bootstrap test; stars from bootstrap p-values, * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

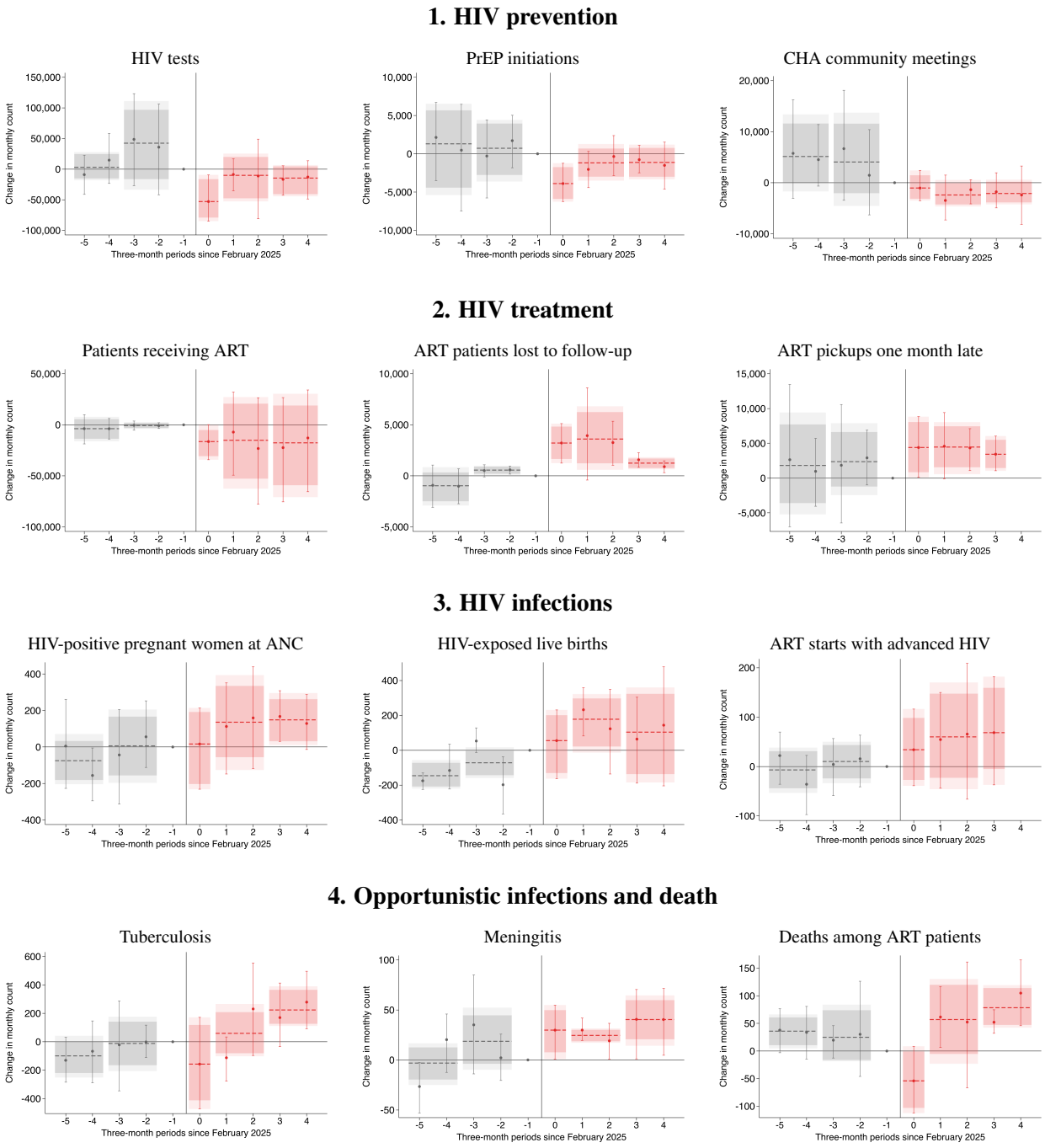


Fig. S4. Event studies with window averages, all facilities: Three-month blocks of the raw outcome, windows 3/6/6, wild cluster bootstrap, North-Western dropped; Lusaka dropped; treatment from February 2025; 15 pre-period months, from November 2023; three-month periods

Dots: event-study coefficients with 95% intervals, before (gray) and after (red) the first treated period; the reference period, the one before it, is the gray dot at zero (no interval). Boxes: the mean coefficient of each window (dashed line), computed with lincom, with its 90% (darker) and 95% (lighter) interval; after February 2025 these are β_1, β_2 and β_3 of Table S8, before it windows of the same kind. Effects are changes in the monthly count, summed over the treated facilities. Intervals from the wild cluster bootstrap by province (Webb weights, 9,999 replications, null imposed; boottest), by inverting the bootstrap test, as in the table; the periods' fixed effects enter as dummies. North-Western's 359 facilities are dropped; treated are the other five USAID provinces.

S9.5 North-Western excluded from treatment, Lusaka included in comparison group

Table S9. Three-month blocks of the raw outcome, windows 3/6/6, wild cluster bootstrap, North-Western dropped; Lusaka in the comparison group; treatment from February 2025; 15 pre-period months, from November 2023; all facilities

Outcome	β_1 Feb-Apr 25	β_2 May-Oct 25	β_3 Nov 25-Apr 26	Mean Nov 24-Jan 25	Pre-period p	R^2
1. HIV prevention						
HIV tests	−43,583*	−8,502	−10,087	228,437	0.83	0.89
	[−79,716, 4,171]	[−44,685, 22,223]	[−38,475, 12,077]			
PrEP initiations	−3,086*	−642	−471	8,265	0.61	0.50
	[−5,788, 396]	[−2,968, 1,980]	[−2,920, 2,230]			
CHA community meetings	−2,020	−1,941	−1,881	5,399	0.34	0.39
	[−5,561, 1,122]	[−4,256, 979]	[−3,920, 453]			
2. HIV treatment						
Patients receiving ART	−17,012**	7,008	1,917	548,237	0.46	0.99
	[−34,509, −4,863]	[−50,550, 91,382]	[−56,799, 80,426]			
ART patients lost to follow-up	3,404***	4,168***	1,580***	4,935	0.18	0.60
	[1,471, 5,201]	[1,593, 7,665]	[746, 2,829]			
ART pickups one month late	7,813**	7,805**	6,930**	7,883	0.57	0.48
	[551, 20,586]	[948, 20,452]	[650, 19,633]			
3. HIV infections						
HIV-positive pregnant women at ANC	28	182	246**	1,483	0.21	0.87
	[−188, 194]	[−64, 456]	[41, 601]			
HIV-exposed live births	−37	77	114	1,437	0.01	0.92
	[−381, 203]	[−289, 308]	[−115, 331]			
ART starts with advanced HIV	24	52	82*	149	0.59	0.47
	[−49, 104]	[−41, 158]	[−1, 198]			
4. Opportunistic infections and death						
Tuberculosis	−102	31	200***	997	0.28	0.90
	[−421, 228]	[−143, 216]	[84, 344]			
Meningitis	15	−14	18	33	0.18	0.40
	[−38, 50]	[−155, 49]	[−64, 62]			
Deaths among ART patients	−36	72*	101***	281	0.19	0.46
	[−102, 41]	[−1, 144]	[43, 182]			
5. Externalities						
Outpatient contacts	−191,045	−152,338	16,133	1,075,159	0.22	0.74
	[−453,850, 68,797]	[−366,853, 90,819]	[−111,273, 153,351]			
Inpatient admissions	375	−2,958	1,783	29,657	0.61	0.86
	[−6,391, 11,072]	[−9,311, 5,686]	[−5,589, 14,619]			

All facilities in the eight provinces of the main analysis sample other than North-Western, plus Lusaka (nine provinces: five USAID, four CDC), November 2023 to the outcome's last month; 3,211 facilities, one observation per facility and block, 10 blocks (9 for ART pickups one month late and ART starts with advanced HIV). Outcome: the raw outcome (zero in a month the facility does not report it, not winsorized), averaged over three-month blocks. β_1, β_2 and β_3 average the event-study coefficients over the blocks in February-April 2025, May-October 2025 and November 2025-April 2026, relative to the reference block, November 2024-January 2025. ART pickups one month late and ART starts with advanced HIV end in December 2025, so their β_3 covers November-December 2025 only. Event study with facility and block fixed effects. Coefficients, confidence intervals and Mean are totals per month over the 1,640 treated facilities (per-facility values times 1,640); Mean is the monthly average over November 2024-January 2025. Pre-period p: wild cluster bootstrap p-value of the joint test that the 4 event-study coefficients before the reference block (from November 2023) are all zero. Inference: wild cluster bootstrap by province (9 clusters; Webb weights, 9,999 replications, null imposed); 95% confidence intervals in brackets, from inverting the bootstrap test; stars from bootstrap p-values, * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

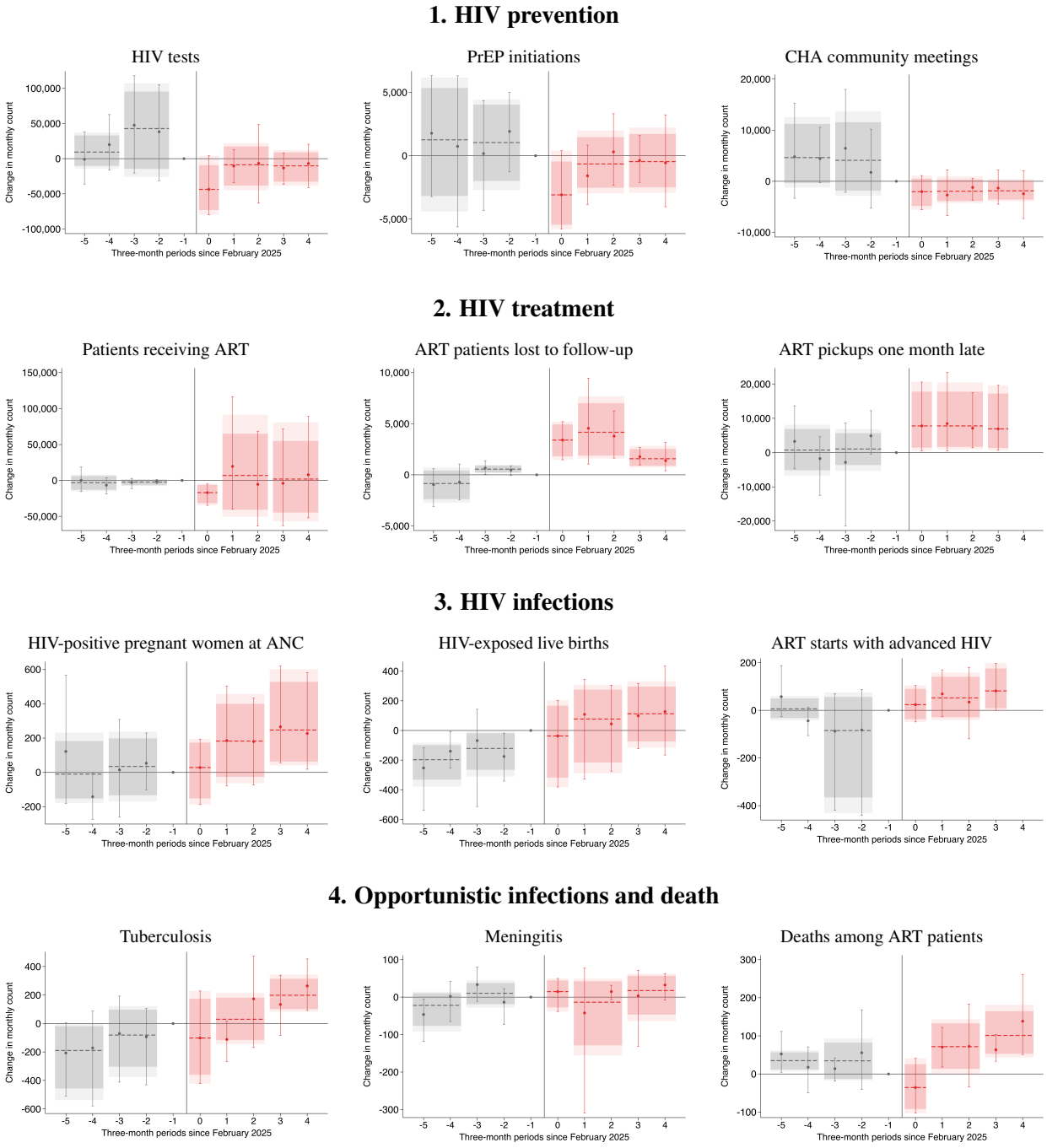


Fig. S5. Event studies with window averages, all facilities: Three-month blocks of the raw outcome, windows 3/6/6, wild cluster bootstrap, North-Western dropped; Lusaka in the comparison group; treatment from February 2025; 15 pre-period months, from November 2023; three-month periods

Dots: event-study coefficients with 95% intervals, before (gray) and after (red) the first treated period; the reference period, the one before it, is the gray dot at zero (no interval). Boxes: the mean coefficient of each window (dashed line), computed with lincom, with its 90% (darker) and 95% (lighter) interval; after February 2025 these are β_1, β_2 and β_3 of Table S9, before it windows of the same kind. Effects are changes in the monthly count, summed over the treated facilities. Intervals from the wild cluster bootstrap by province (Webb weights, 9,999 replications, null imposed; boottest), by inverting the bootstrap test, as in the table; the periods' fixed effects enter as dummies. North-Western's 359 facilities are dropped; treated are the other five USAID provinces.

S9.6 Deaths among ART patients: with and without Lusaka and North-Western

We show the sensitivity of our main results on deaths among ART patients to ambiguity in the geographical coverage of USAID and CDC support. In particular, we compare all four permutations that arise from the inclusion of Lusaka province in the comparison group and the exclusion of North-Western province from the treatment group in table S10 below. Panel A shows the total effect over the entire 15 months post-freeze period, while Panel B shows the effect for the final six months post-freeze alone. The main results reported above are represented in the first column and first row of each panel, which confirm that our estimates of additional deaths among ART patients are conservative.

Table S10. Total and final period additional deaths among ART patients, with and without Lusaka and North-Western

	North-Western in treatment group	North-Western excluded
Panel A: February 2025-April 2026 (15 months)		
Lusaka excluded	625	651*
	[−266, 1,665]	[−73, 1,456]
Lusaka in comparison group	963*	929**
	[−134, 2,235]	[33, 1,970]
Panel B: November 2025-April 2026 (final period, 6 months)		
Lusaka excluded	486**	471***
	[142, 837]	[254, 716]
Lusaka in comparison group	650***	606***
	[206, 1,292]	[260, 1,091]

Additional deaths among ART patients in the treated facilities over the panel's months. Panel A: three times the sum of the five post-period block coefficients of the event study (three times β_1 plus six times β_2 plus six times β_3). Panel B: three times the sum of the last two block coefficients (six times β_3). Each coefficient is relative to the reference block November 2024-January 2025 and is multiplied by the number of treated facilities (1,999 with North-Western in treatment group, 1,640 with North-Western excluded). Raw outcome, three-month blocks, facility and block fixed effects; the coefficients are those of Tables S3 (North-Western in treatment group, Lusaka excluded: the main specification), S8 (North-Western excluded, Lusaka excluded), S7 (North-Western in treatment group, Lusaka in comparison group) and S9 (North-Western excluded, Lusaka in comparison group). 95% confidence intervals in brackets, from inverting the wild cluster bootstrap test of each sum (province clusters: 9 and 8 with Lusaka excluded, 10 and 9 with Lusaka in comparison group; Webb weights, 9,999 replications, null imposed); stars from the bootstrap p-values, * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

S9.7 Balanced panel

Facility closures were reported in other parts of sub-Saharan Africa following the USAID shutdown. We therefore highlight that our results are not driven by differential facility entry or exit. To this end, we replicate our main analysis on a balanced sample of facilities. As table S11 shows, this does not alter our main results.

Table S11. Three-month blocks of the raw outcome, windows 3/6/6, balanced panel, wild cluster bootstrap; Lusaka dropped; treatment from February 2025; 15 pre-period months, from November 2023; facilities that report in the outcome's section every month

Outcome	β_1 Feb-Apr 25	β_2 May-Oct 25	β_3 Nov 25-Apr 26	Mean Nov 24-Jan 25	Pre-period p	R^2
1. HIV prevention						
HIV tests	−52,741**	−10,948	−18,491*	199,959	0.77	0.84
	[−84,190, −13,637]	[−42,110, 21,587]	[−38,639, 943]			
PrEP initiations	−521	−68	−73	900	0.01	0.49
	[−944, 180]	[−377, 703]	[−503, 282]			
CHA community meetings	205	5	95	103	0.05	0.51
	[−70, 650]	[−69, 195]	[−275, 774]			
2. HIV treatment						
Patients receiving ART	−15,193*	−14,376	−18,768	569,928	0.63	0.99
	[−36,459, 3,088]	[−66,998, 29,027]	[−79,634, 33,018]			
ART patients lost to follow-up	3,018**	3,118*	422	5,729	0.21	0.60
	[1,030, 5,084]	[−170, 6,906]	[−1,351, 2,121]			
ART pickups one month late	4,518**	4,282**	2,901**	8,482	0.75	0.66
	[410, 9,511]	[597, 8,096]	[282, 5,649]			
3. HIV infections						
HIV-positive pregnant women at ANC	−17	87	92	1,298	0.03	0.77
	[−245, 170]	[−142, 321]	[−44, 239]			
HIV-exposed live births	27	65	33	1,074	0.20	0.91
	[−108, 133]	[−51, 176]	[−18, 83]			
ART starts with advanced HIV	27	64	83*	170	0.59	0.46
	[−51, 107]	[−30, 169]	[−16, 200]			
4. Opportunistic infections and death						
Tuberculosis	−145	8	167	814	0.55	0.80
	[−372, 86]	[−212, 239]	[−47, 389]			
Meningitis	30**	24***	47**	30	0.38	0.56
	[6, 54]	[12, 37]	[13, 80]			
Deaths among ART patients	−58**	42	69**	292	0.37	0.44
	[−116, −6]	[−37, 106]	[23, 108]			
5. Externalities						
Outpatient contacts	−104,944	−80,464	20,532	630,445	0.16	0.86
	[−253,988, 48,335]	[−245,415, 95,139]	[−61,571, 97,339]			
Inpatient admissions	−1,065	−3,519	−3,225	17,767	0.92	0.90
	[−3,958, 1,808]	[−7,637, 1,218]	[−7,685, 1,047]			

Balanced panel of the facilities in the nine provinces of the main analysis sample (six USAID, three CDC), November 2023 to the outcome's last month; one observation per facility and block, 10 blocks (9 for ART pickups one month late and ART starts with advanced HIV). Facilities per outcome: HIV tests 1,862; PrEP initiations 51; CHA community meetings 34; Patients receiving ART 2,219; ART patients lost to follow-up 2,219; ART pickups one month late 2,338; HIV-positive pregnant women at ANC 1,603; HIV-exposed live births 1,603; ART starts with advanced HIV 2,338; Tuberculosis 197; Meningitis 2,238; Deaths among ART patients 2,219; Outpatient contacts 1,455; Inpatient admissions 200. Outcome: the raw outcome (zero in a month the facility does not report it, not winsorized), averaged over three-month blocks. Balanced panel: for each outcome, only the facilities that report in the outcome's form section (any of its indicators; e.g. HIA2 section 4.3 ART, or the HIA1, TB weekly or CHA forms) in every month from November 2023 to April 2026 (December 2025 for the two outcomes that end then). β_1, β_2 and β_3 average the event-study coefficients over the blocks in February-April 2025, May-October 2025 and November 2025-April 2026, relative to the reference block, November 2024-January 2025. ART pickups one month late and ART starts with advanced HIV end in December 2025, so their β_3 covers November-December 2025 only. Event study with facility and block fixed effects. Coefficients, confidence intervals and Mean are totals per month over the treated facilities (per-facility values times their number, 9 to 1,336 by outcome); Mean is the monthly average over November 2024-January 2025. Pre-period p: wild cluster bootstrap p-value of the joint test that the 4 event-study coefficients before the reference block (from November 2023) are all zero. Inference: wild cluster bootstrap by province (9 clusters, 7 for CHA community meetings; Webb weights, 9,999 replications, null imposed); 95% confidence intervals in brackets, from inverting the bootstrap test; stars from bootstrap p-values, * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

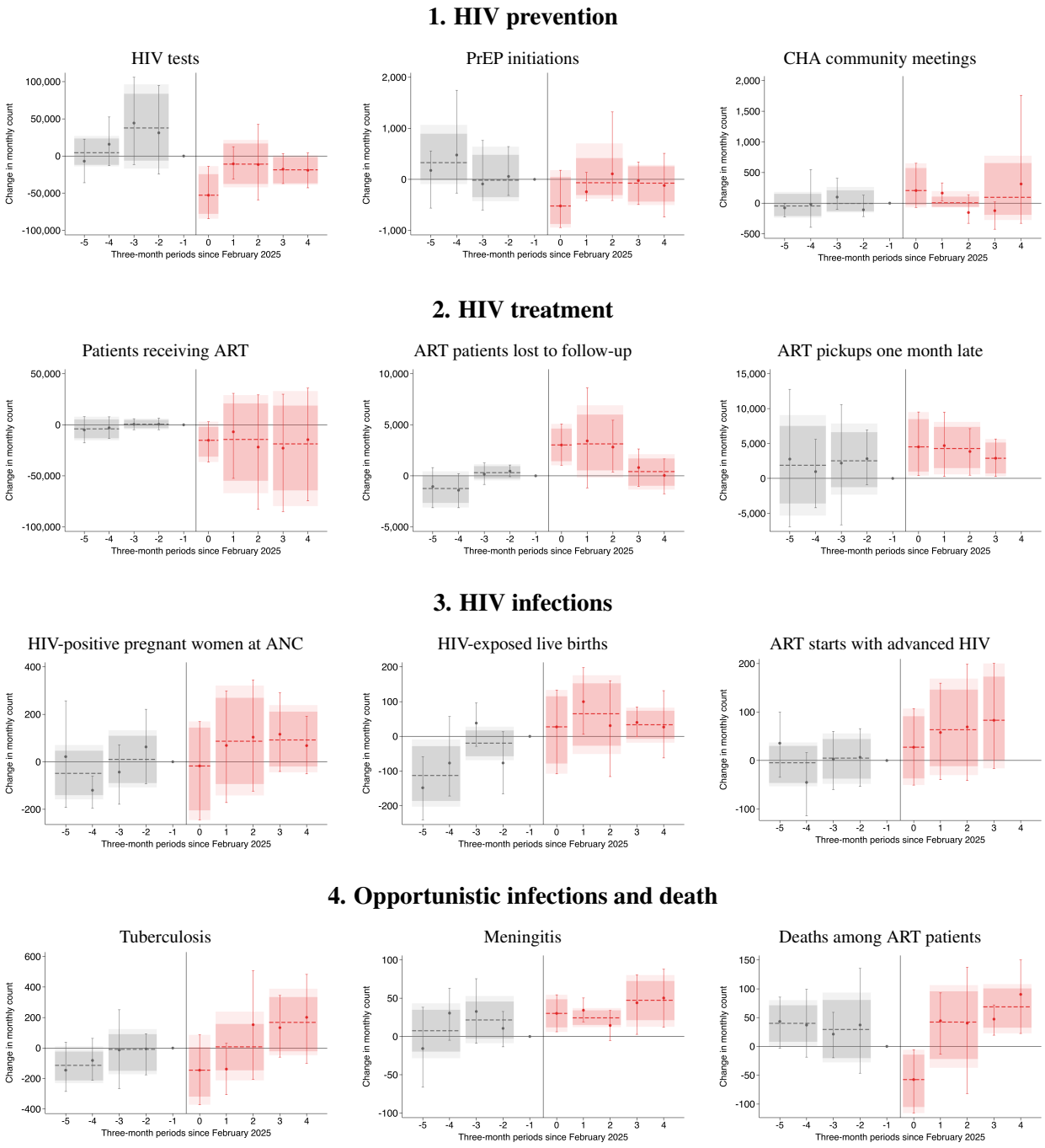


Fig. S6. Event studies with window averages: Three-month blocks of the raw outcome, windows 3/6/6, balanced panel, wild cluster bootstrap; Lusaka dropped; treatment from February 2025; 15 pre-period months, from November 2023; facilities that report in the outcome's section every month; three-month periods

Dots: event-study coefficients with 95% intervals, before (gray) and after (red) the first treated period; the reference period, the one before it, is the gray dot at zero (no interval). Boxes: the mean coefficient of each window (dashed line), computed with lincom, with its 90% (darker) and 95% (lighter) interval; after February 2025 these are β_1, β_2 and β_3 of Table S11, before it windows of the same kind. Effects are changes in the monthly count, summed over the treated facilities. Intervals from the wild cluster bootstrap by province (Webb weights, 9,999 replications, null imposed; boottest), by inverting the bootstrap test, as in the table; the periods' fixed effects enter as dummies.

S9.8 Monthly, de-seasonalized data

Table S12. Raw outcome by month, de-seasonalized by province and calendar month, windows 3/6/6, wild cluster bootstrap; Lusaka dropped; treatment from February 2025; 15 pre-period months, from November 2023; all facilities

Outcome	β_1 Feb-Apr 25	β_2 May-Oct 25	β_3 Nov 25-Apr 26	Mean Nov 24-Jan 25	Pre-trend p	R^2
1. HIV prevention						
HIV tests	−81,880**	−58,072	−19,117	298,102	0.59	0.75
	[−145,248, −18,776]	[−130,416, 22,298]	[−55,629, 21,123]			
PrEP initiations	−3,565	−514	−463	9,527	0.40	0.38
	[−9,269, 2,868]	[−2,371, 1,491]	[−3,507, 2,266]			
CHA community meetings	−172	−2,737	−1,636	7,720	0.14	0.21
	[−4,833, 4,493]	[−9,622, 3,570]	[−7,995, 4,815]			
2. HIV treatment						
Patients receiving ART	−15,969*	−14,775	−11,287	592,987	0.88	0.99
	[−35,151, 2,260]	[−63,632, 29,108]	[−70,392, 44,768]			
ART patients lost to follow-up	4,052**	2,666*	1,308	6,053	0.19	0.40
	[1,814, 6,191]	[−596, 5,969]	[−1,130, 3,807]			
ART pickups one month late	2,793	1,528	1,578	7,725	0.55	0.53
	[−3,216, 8,750]	[−1,995, 6,295]	[−2,305, 5,996]			
3. HIV infections						
HIV-positive pregnant women at ANC	182*	108	262**	1,615	0.78	0.52
	[−18, 374]	[−256, 503]	[40, 454]			
HIV-exposed live births	127	229	194	1,541	0.01	0.77
	[−325, 493]	[−72, 456]	[−275, 500]			
ART starts with advanced HIV	88**	73*	67*	189	0.20	0.26
	[2, 169]	[−16, 168]	[−18, 155]			
4. Opportunistic infections and death						
Tuberculosis	−130	23	288**	1,135	0.09	0.72
	[−287, 89]	[−291, 341]	[13, 593]			
Meningitis	−27*	−26	3	47	0.48	0.31
	[−52, 2]	[−70, 17]	[−37, 39]			
Deaths among ART patients	−78*	59	74**	335	0.06	0.22
	[−158, 10]	[−24, 142]	[17, 132]			
5. Externalities						
Outpatient contacts	−259,549*	−20,254	−17,854	1,324,608	0.08	0.45
	[−680,033, 30,844]	[−99,408, 59,008]	[−187,986, 221,364]			
Inpatient admissions	−1,979	−5,218	−2,452	35,878	0.81	0.73
	[−10,493, 7,295]	[−13,503, 3,165]	[−12,379, 6,955]			

All facilities in the nine provinces of the main analysis sample (six USAID, three CDC), November 2023 to the outcome's last month; 3,294 facilities, one observation per facility and month, 30 months (26 for ART pickups one month late and ART starts with advanced HIV). Outcome: the raw outcome (zero in a month the facility does not report it, not winsorized) by month, minus its province $\times$ calendar-month seasonal component: the province's mean in that calendar month over the pre-shutdown months (November 2023 to January 2025), less the mean of its 12 such values. β_1, β_2 and β_3 average the event-study coefficients over February-April 2025, May-October 2025 and November 2025-April 2026, relative to the reference month, January 2025. ART pickups one month late and ART starts with advanced HIV end in December 2025, so their β_3 covers November-December 2025 only. Event study with facility and calendar-month fixed effects. Coefficients, confidence intervals and Mean are totals per month over the 1,999 treated facilities (per-facility values times 1,999); Mean is the monthly average of the de-seasonalized outcome (not of the raw outcome, so it differs from the main table's Mean) over November 2024-January 2025. Pre-trend p: wild cluster bootstrap p-value of δ in the regression of the outcome on the fixed effects and treated $\times$ month, on the months up to January 2025 only. The joint test of the 14 pre-period coefficients cannot be computed here: with 9 clusters the clustered variance matrix has rank at most 8. Inference: wild cluster bootstrap by province (9 clusters; Webb weights, 9,999 replications, null imposed); 95% confidence intervals in brackets, from inverting the bootstrap test; stars from bootstrap p-values, * p$<$0.10, ** p$<$0.05, *** p$<$0.01.

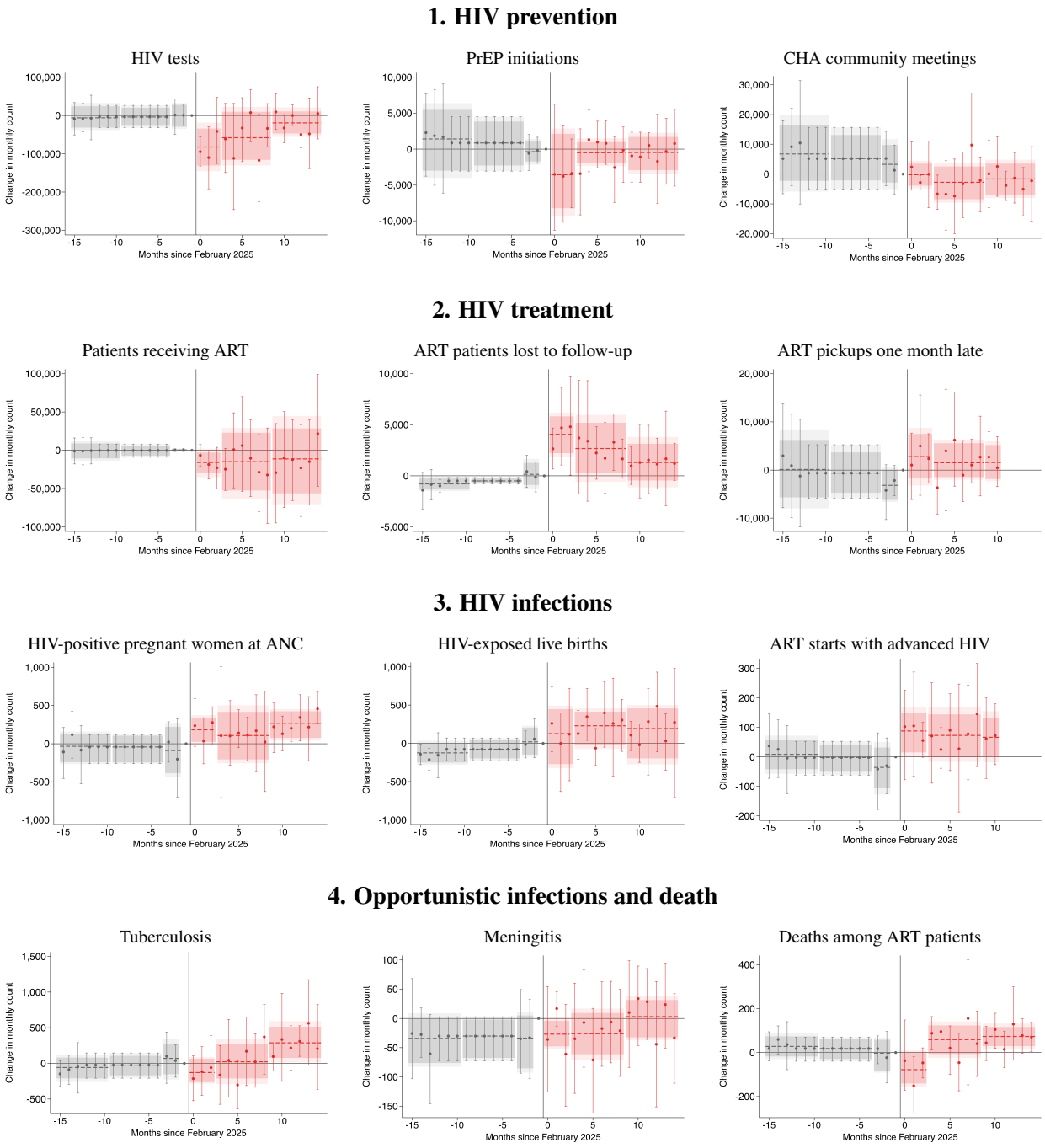


Fig. S7. Event studies with window averages, all facilities: Raw outcome by month, de-seasonalized by province and calendar month, windows 3/6/6, wild cluster bootstrap; Lusaka dropped; treatment from February 2025; 15 pre-period months, from November 2023

Dots: event-study coefficients with 95% intervals, before (gray) and after (red) the first treated period; the reference period, the one before it, is the gray dot at zero (no interval). Boxes: the mean coefficient of each window (dashed line), computed with lincom, with its 90% (darker) and 95% (lighter) interval; after February 2025 these are β_1, β_2 and β_3 of Table S12, before it windows of the same kind. Effects are changes in the monthly count, summed over the treated facilities. Intervals from the wild cluster bootstrap by province (Webb weights, 9,999 replications, null imposed; boottest), by inverting the bootstrap test, as in the table; the periods' fixed effects enter as dummies.

S9.9 PEPFAR-MER based estimates of the US aid freeze

PEPFAR's Monitoring, Evaluation, and Reporting (MER) system collects quarterly data on 25 service delivery indicators from the universe of PEPFAR-supported health facilities through an electronic reporting system. The official 2025 monitoring data were released on April 17, 2026, but only included data from the fourth quarter of 2025. Data from the first three quarters were withheld due to data quality concerns as the US aid freeze had disrupted not only service delivery but also data entry. However, an unofficial dataset released on the PEPFAR development dashboard in January 2026 contains data for all quarters of 2025, as detailed by Honermann *et al.* (*29*).

We use this unofficial dataset to validate the differential impact of the aid freeze on USAID-relative to CDC-supported health facilities in Zambia. As true zeros in PEPFAR-MER cannot be distinguished from missing reports, we treat all missing values in the data as zeros. This allows us to estimate an upper bound on the reduction in HIV testing and prophylaxis. As shown in Fig. S8, we find remarkably similar patterns of service disruption and recovery in PEPFAR-MER and HMIS data, with somewhat larger reductions in the former.

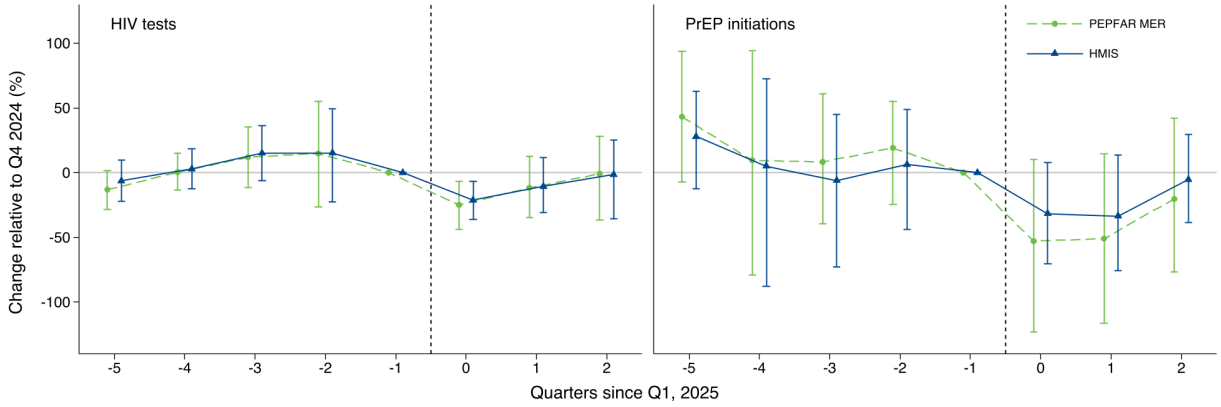


Fig. S8. Impact on HIV testing and PrEP in PEPFAR-MER vs. HMIS data

This figure plots event study coefficients from a difference-in-differences specification with facility and quarter fixed effects comparing outcomes in USAID-supported and CDC-supported provinces of Zambia before and after the 2025 US aid freeze. Estimates shown in green are based on the January 2026 unofficial release of PEPFAR-MER. Estimates shown in blue are based on HMIS data aggregated at the facility-quarter level for comparability with the PEPFAR-MER data. Dots represent point estimates. Bars indicate 95% confidence intervals from a wild cluster bootstrap by province using Webb weights on 9,999 replications and an imposed null.

S10 Additional results on externalities on other health services

We report the total change in outpatient contacts and inpatient admissions of the 15 month period after the freeze, and the initial nine months in table S13 below. Outpatient contacts are statistically significantly negative and different from zero at 5% level in the first nine months post-freeze, whereas the total change in inpatient admissions over either time period, and outpatient contacts over 15 months are statistically significantly negative and different from zero at 10% level.

Table S13. Total change in outpatient contacts and inpatient admissions at USAID-supported facilities

	February 2025-April 2026 (15 months)	February-October 2025 (9 months)
Outpatient contacts	−2,353,529* [−5,062,328, 114,929]	−2,155,385** [−4,524,182, −238,602]
Inpatient admissions	−102,809* [−224,008, 16,115]	−75,187* [−160,044, 1,013]

All facilities in the nine provinces of the main analysis sample (six USAID, three CDC). Change at the 1,999 USAID-supported facilities over the months of each column, relative to the reference block November 2024-January 2025. Outpatient contacts are first attendances (visits, not distinct people); inpatient admissions are admissions. 15 months: three times β_1 plus six times β_2 plus six times β_3; February-October 2025: three times β_1 plus six times β_2; the coefficients are those of Table S3 (monthly totals over the treated facilities). 95% confidence intervals in brackets, from inverting the wild cluster bootstrap test of each sum (9 province clusters; Webb weights, 9,999 replications, null imposed); stars from the bootstrap p-values, * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

Any disruption to the health system should have affected PEPFAR-funded facilities that offered HIV/ART-related services more severely than those that did not. However, the shutdown may have also caused disruption to non-HIV/ART-related service-offering facilities. Fig. S9 confirms that ART-providing facilities bore the brunt of the shock and decreased both outpatient and inpatient services, whereas even non-ART-providing facilities experience decreases to outpatient services in the first three months after the shutdown.

These findings are in line with substantial externalities on non-PEPFAR-funded health services in USAID provinces. Eventually, these other health system outcomes open up the possibility that long-term consequences may emerge after the end of our data that our mortality estimates currently fail to capture. Such 'ripple effects' are in line with qualitative evidence that "diverting resources to HIV services may exacerbate existing funding gaps [for] maternal and child health" (*13*), some of the most common patient services.

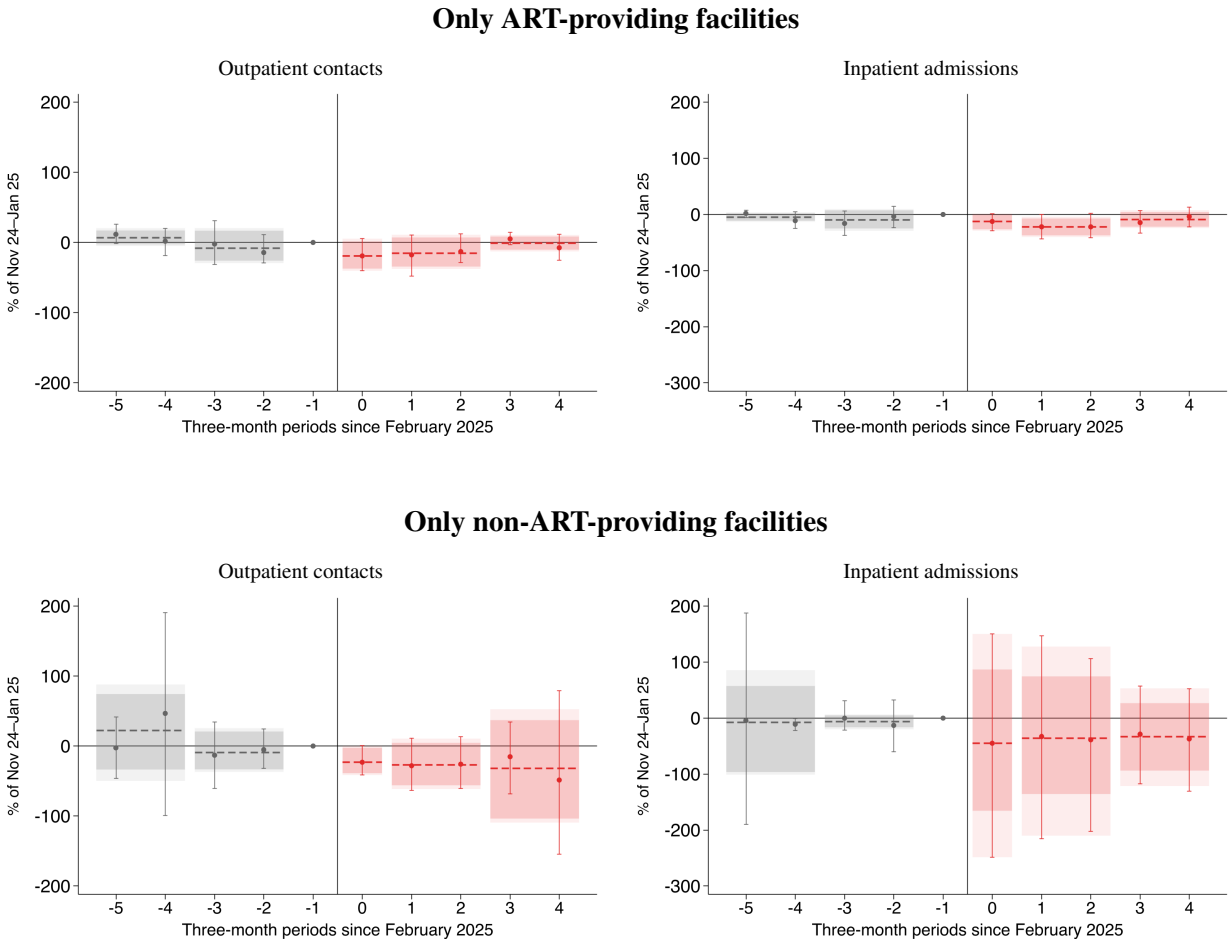


Fig. S9. Effect of USAID shutdown on health system service delivery by ART provision

All outcomes expressed as percentage change relative to the November 2024-January 2025 period, the mean of the USAID-supported facilities in each panel. All health facilities in Zambia that report to HMIS included in sample except for facilities in Lusaka province. The upper panel includes only facilities that report non-zero ART patients in any month in 2024. The lower panel includes only facilities that report zero ART patients in all months of 2024. Each outcome has the same y-axis in both panels. Observations at the facility-period-level, where a period equals a three-month window. Difference-in-differences specification with facility and period fixed effects, comparing USAID- to CDC- administered facilities across Zambian provinces. Red (gray) dots represent point estimates for the treatment (placebo) periods. Colored bars indicate 95% confidence intervals. Horizontal red (gray) dashed lines indicate the mean coefficient of each treatment (placebo) period three/six-month window, red (gray) boxes the corresponding 90% (darker) and 95% (lighter) confidence intervals. Standard errors are wild cluster bootstrapped at the province level using Webb weights on 9,999 replications and an imposed null.

S11 Comparison with ex ante projections

Two models projected HIV mortality in Zambia from the 2025 freeze shortly after the freeze was announced. Mulenga *et al.* (*13*), built with the Ministry of Health (EMOD-HIV, assumptions fixed in February to March 2025), varies only the duration of the disruption and labels results by it ("3 M", "1 Y", "4 Y", "Unabated"; their table 2). Under the 3-month disruption, 40% of clients at facilities in the five provinces with USAID-employed front-line staff lose access to treatment, attrition rises from 5% to 20% per year, PrEP is restricted to pregnant and breastfeeding women and circumcision stops, all for three months, after which services return to 2024 coverage. The projection is 32,550 additional HIV deaths over 2025 to 2060, all ages (sensitivity range 22,940 to 43,470 for attrition of 10% to 30%). Hontelez *et al.* (*21*) (STDSIM, seven countries, ages 15 and over) models a 90-day PEPFAR freeze under four scenarios, labeled in their table 1 "Executive order-realistic", "Executive order-proportional", "Waiver-8 weeks" and "Waiver-4 weeks". In all four, affected patients default within a month and re-initiate over six months once funding returns; the scenarios differ in the share affected (90%, or 77% in the proportional scenario) and in how long treatment is off (90 days, 8 weeks, 4 weeks). Zambia projections for 2025 to 2030 are 10,700, 9,800, 3,700 [95% UI 3,000 to 4,400] and 2,700 deaths.

Neither projection is directly comparable to our estimate, which covers six provinces, six months, and deaths recorded in the ART register. Table S14 scales the two projections to the geographic coverage, time period, and population on which we base our estimate.

Scenario choice. For Mulenga *et al.* (*13*) we use the 3-month disruption: the other durations assume a disruption of one year or longer, whereas treatment support in Zambia was restored within months (the waiver of February 1, 2025, about a year of ARV stock, no national stockout, absorption of PEPFAR-funded staff by the Ministry). For Hontelez *et al.* (*21*) we use "Waiver-8 weeks". This scenario is closest to what occurred. The "Executive order" scenarios, in which 77 to 90% of patients are off treatment for three months and take six more to restart, did not occur (patients on ART in USAID provinces fell by at most 3%). The "Waiver-4 weeks" scenario is too short, since USAID-supported services remained disrupted for at least three months. On duration this understates the shock (loss to follow-up stayed elevated through October 2025); on magnitude it overstates it by 30 to 45-fold (90% defaulting versus a 2 to 3% fall in patients on treatment).

Provinces. USAID-supported provinces held 44% of Zambia's patients on PEPFAR-supported treatment (565,000 of 1.28 million, TX_CURR by funding agency, FY2024 Q4 (*73*)). The Hontelez *et al.* (*21*) shock is national and uniform, so we multiply their estimates by 0.44. For Mulenga *et al.* (*13*) the factor is 0.53 rather than 0.44 because their model places one of its two shocks, the loss of treatment access, only in five provinces, all of which are in our treated group. Their sensitivity analysis (28,790 and 37,420 deaths at 10% and 70% access loss) attributes 5,200 of the 32,550 to access loss, giving $(5{,}200 + 0.44 \times 27{,}350)/32{,}550 = 0.53$.

Period. The time period for our estimate is November 2025 to April 2026. For Hontelez *et al.* (*21*) we digitized the Zambia panel of their appendix fig. A11 (deaths per quarter by scenario). Excess deaths under "Waiver-8 weeks" are about 340, 650, 810, 630, 440, 350, 300 and 250 in the eight quarters of 2025 and 2026 and near zero thereafter (sum 3,770 against the published 3,700),

so the window captures 26% of the total. Mulenga *et al.* (*13*) publishes no annual series for the 3-month disruption. Their text states that mortality rates return to baseline the following year, but the disruption also adds 54,860 infections, whose deaths at baseline rates accumulate for decades; in their fig. 1 the 3-month curve stays above the no-disruption curve through 2060, and most of the 32,550 deaths occur after 2030. Reading the gap between the 3-month and no-disruption curves in their fig. 1 (2025 excess as in their Supplementary Table 8, 5,011; 2026 about 2,400) and spreading each year's deaths evenly over its months implies about 1,640 deaths in our window, 0.050 of the total (0.044 to 0.057 across readings). Their Supplementary Table 8 gives cumulative adult excess deaths for the unabated disruption (1,373 through 2025, 6,626 through 2026); since that scenario coincides with the 3-month one through March 2025 and is worse thereafter, adult excess deaths in our window under the 3-month disruption cannot exceed about 2,000 nationally, whatever the figure reading.

Population. Our estimate counts deaths among people on ART; the projection models predict all HIV deaths. Hontelez *et al.* (*21*) covers ages 15 and over, so only treatment status matters. The split between deaths among people on and not yet on treatment at the freeze is reported only for "Executive order-realistic" (appendix fig. A15): with initiations halted for nine months, 40 to 50% of excess deaths occur among the untreated. Under "Waiver-8 weeks" initiations stop for eight weeks, so the untreated share must be smaller; we multiply their estimate by 0.60 to 0.85. Mulenga *et al.* (*13*) covers all ages. Children under 15, infected through the PMTCT disruption and never on ART, account for 69% of the 2025 excess and 30% of the 2026 increment, and adults for 27% and 69% (their Supplementary Table 8; the three age-sex groups sum to 97% and 99% of the "All" column in that table). Our window includes 835 of the 3-month scenario's deaths from the two months of 2025 and 800 from the four months of 2026 (see Period above), so adults are $(0.27 \times 835 + 0.69 \times 800)/1{,}635 = 0.48$ of the projected deaths in the window (0.44 to 0.50 across readings of the 2026 excess). Among adults, the attrition channel affects only people on treatment and the access channel covers "new and returning clients", so we keep 0.8 to 0.9.

Under-recording. Holmes *et al.* (*44*) traces a probability sample of patients lost from 64 Zambian facilities and finds two-year mortality of 7.0% [95%-CI: 5.7, 8.4] against 1.9% (1.7 to 2.0) in the records, a factor of 3.68 (2.85 to 4.94 at the interval ends).

Result. Scaled to our provinces, period, and population, the projections imply 250 to 360 deaths (*21*) and 330 to 370 (*13*). We estimate 486 [95%-CI: 142, 837]: 1.35 to 1.9 and 1.3 to 1.5 times the projections on recorded deaths. Corrected for under-recording, this yields 1,790 (520 to 3,080; 1,390 to 2,400 across the factor range): our estimated mortalities are 5.0 to 7.2 and 4.8 to 5.4 times the projections, and at least 1.9 times the largest value consistent with supplementary table 8 of Mulenga *et al.* (*13*).

Table S14. Reconciliation of our estimate with ex ante projections, November 2025 to April 2026. Brackets: 95% sampling interval (ours), 95% uncertainty interval propagated through the same factors (*21*), or sensitivity range combined with the range of figure readings (*13*).

Reconciliation step	This paper	Hontelez *et al.* (*21*), "Waiver-8 weeks"	Mulenga *et al.* (*13*), 3-month disruption
Published projection	486 recorded [142, 837]	3,700 [3,000, 4,400], Zambia, ages 15+, 2025-2030	32,550 [22,940, 43,470], Zambia, all ages, 2025-2060
To USAID-supported provinces	486	$\times$0.44: 1,630	$\times$0.53: 17,250
To the window, adults	486	$\times$0.26: 420 [340, 500]	$\times 0.050 \times 0.48$: 410 [260, 630]
To people on ART	486	$\times$0.60-0.85: 250-360 [210, 430]	$\times$0.8-0.9: 330-370 [210, 570]
Ratio, recorded count to projection		1.35-1.9	1.3-1.5
Correction for unrecorded deaths (*44*)	$\times$3.68: 1,790 [520, 3,080]		
Ratio, corrected count to projection		5.0-7.2	4.8-5.4