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Journal
AIDS, 30(10)

ISSN
0269-9370

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Publication Date
2016-06-19

DOI
10.1097/qad.0000000000001111

Peer reviewed

HHS Public Access

Author manuscript

AIDS. Author manuscript; available in PMC 2017 June 19.

Published in final edited form as:

AIDS. 2016 June 19; 30(10): 1655–1662. doi:10.1097/QAD.0000000000001111.

Option A Improved HIV-free Infant Survival and Mother to Child HIV Transmission at 9–18 Months in Zimbabwe

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Abstract

Objective—We evaluated the impact of Option A on HIV-free infant survival and mother-to-child transmission (MTCT) in Zimbabwe.

Design—Serial cross-sectional community-based serosurveys.

Methods—We analyzed serosurvey data collected in 2012 and 2014 among mother-infant pairs from catchment areas (CAs) of 132 health facilities from 5 of 10 provinces in Zimbabwe. Eligible infants (alive or deceased) were born 9–18 months before each survey to mothers ≥16 years old. We randomly selected mother-infant pairs and conducted questionnaires, verbal autopsies and collected blood samples. We estimated: 1) the HIV-free infant survival and MTCT rate within each CA and compared the 2012 and 2014 estimates using a paired t-test, 2) number of HIV infections averted due to the intervention.

Results—We analyzed 7,249 mother-infant pairs with viable maternal specimens collected in 2012 and 8,551 in 2014. The mean difference in the CA-level MTCT between 2014 and 2012 was −5.2 percentage points (95% confidence interval (CI)=−8.1, −2.3, p<0.001). The mean difference

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CONFLICTS OF INTEREST: The authors have no conflict of interests.

in the CA-level HIV-free survival was 5.5 percentage points (95%CI=2.6,8.5, p<0.001). Between 2012 and 2014, 1,779 infant infections were averted compared to the pre-Option A regimen. The association between HIV-free infant survival and duration of Option A implementation was not significant at the multivariate level (p=0.093).

Conclusions—We found a substantial and statistically significant increase in HIV-free survival and decrease in MTCT among infants aged 9–18 months following Option A rollout in Zimbabwe. This is the only impact evaluation of Option A and shows the effectiveness of Option A and Zimbabwe's remarkable progress towards eMTCT.

Keywords

Option A; impact evaluation; HIV-free infant survival; mother to child transmission of HIV; vertical transmission of HIV; elimination of mother to child transmission of HIV; Zimbabwe

INTRODUCTION

New pediatric HIV infections globally declined by 58% between 2000 and 2014,[1] largely due to the implementation of increasingly efficacious drug regimens for the prevention of mother-to-child transmission of HIV (PMTCT). Nonetheless, in 2014, 220,000 children became infected with HIV worldwide and 190,000 of them were in sub-Saharan Africa.[1] The World Health Organization (WHO) has regularly updated their PMTCT guidelines for developing countries in response to new evidence about the efficacy of PMTCT regimens. In 2010, WHO recommended Option A, namely: i) HIV-infected pregnant women eligible for antiretroviral therapy (ART, i.e., CD4≤350/μL or Stage 3–4 disease) receive lifelong therapy, and ii) ART-ineligible women (i.e., CD4>350/μL and Stage 1–2 disease) receive antiretroviral (ARV) prophylaxis during pregnancy (starting at 14 weeks), labor and postpartum; their infants also receive prophylaxis throughout breastfeeding.[2] In 2013, WHO updated their guidelines, recommending that all pregnant women, regardless of clinical stage, receive ART at a minimum during pregnancy and breastfeeding (Option B) or ideally lifelong (Option B+).[3]

Many developing countries have adopted the 2010 or the 2013 WHO-recommended regimens,[4] and have aligned themselves with the global goal to achieve virtual elimination of MTCT (MTCT <5%) by 2015.[5] Consequently, there are increased efforts in monitoring countries' progress towards this goal. There is little empirical evidence of the population-level impact of Option A on reducing MTCT. Although WHO guidelines have shifted to Option B+, documenting the effectiveness of Option A provides a baseline against which to evaluate the impact of Option B+ and to identify implementation issues relevant for ongoing PMTCT programming.

We assessed the impact of Option A on MTCT using data from Zimbabwe, where 16% of pregnant women were estimated to be HIV-infected in 2012,[6] and 10% of their infants were estimated to be infected in 2013.[7] We conducted an impact evaluation (IE) of this PMTCT program in parallel with the implementation of Option A, which began in 2011, using two population-based cross-sectional serosurveys of mother-infant pairs (in 2012 and 2014). We previously reported the estimates from the baseline survey.[8,9] Here we present

the IE results, which had the following objectives: 1) estimate the impact of Option A in Zimbabwe on MTCT and HIV-free infant survival at 9–18 months after two years of implementation, and 2) determine whether the effects were stronger in catchment areas (CAs) where Option A was established earlier.

METHODS

Zimbabwe's PMTCT Program

In 2011 the Zimbabwe Ministry of Health and Child Care (MoHCC) adopted and implemented Option A nationally. MoHCC distributed point-of-care CD4 testing machines for determination of ART eligibility, and facilitated community mobilization to increase entry and retention in the PMTCT cascade. UNAIDS commended the Zimbabwe MoHCC for this successful countrywide implementation.[10] Zimbabwe began rollout of Option B+ in November 2013.

Study Design

We conducted two cross-sectional population-representative surveys of mother-infant pairs in five of Zimbabwe's ten provinces to estimate the difference in CA-level MTCT and HIV-free infant survival before and after Option A implementation (Figure 1). Detailed methodology for this study has been previously described.[8,9]

Study population

The study population consisted of infants born 9–18 months before the survey and their biological mothers or caregivers aged ≥16 years old (henceforth called "mother-infant pairs"). We included infants 9–18 months old to be able to detect HIV transmissions occurring during pregnancy, delivery, and breastfeeding.[2] To estimate the impact of Option A, the study population was limited to HIV-infected women and their infants.

Sampling strategy

Eligible mother-infant pairs were selected using a three-stage sampling strategy: selection of provinces, facility CAs, and mother-infant pairs.

Stage 1—We selected five of Zimbabwe's ten provinces (Harare, Mashonaland West, Mashonaland Central, Manicaland, Matabeleland South), as resources for the evaluation precluded sampling the entire country. These included three of the four largest cities in Zimbabwe, rural communities with high and low HIV prevalence, areas where detailed monitoring data were being collected, and representation of both major ethnic groups in Zimbabwe (Shona, Ndebele).

Stage 2—In 2012, we randomly selected 157 of 699 CAs of health facilities in these provinces where PMTCT services were available. At each facility in a selected CA, we administered a questionnaire with head nurses to capture the services delivered at that facility and the timing of Option A rollout. The CAs of these facilities, which are geographical areas defined by the MoHCC, were primary sampling units and were randomly sampled proportionate to the number of CAs in their district.

Stage 3—In each sampled CA, we identified all eligible infants and sampled a predetermined fraction of them with the objective of enrolling 50 infants per CA (according to our power calculations). Infants born in the previous two years were identified based on information pooled from community health workers and immunization registers from selected facilities and neighboring facilities (to identify women residing in sampled facilities who accessed services at adjacent facilities). Further, mothers identified using either method were asked to identify other eligible infants in their neighborhood. This three-pronged approach efficiently identified eligible participants without screening all the households in the selected CAs and captured mother-infant pairs who received care outside their area of residence.

Data collection

Participating mothers/caregivers answered interviewer-administered questionnaires capturing mothers' experience of health services. If participants had medical records in their possession (i.e., infant/maternal health card), interviewers collected documented information on HIV status. Living biological mothers and infants provided dried blood spot samples for HIV testing. If the biological mother of an eligible infant was deceased, we interviewed the caregiver to ascertain the probable cause of death. If the eligible infant was deceased, we interviewed the mother to assess the baby's likely cause of death. We used adapted verbal autopsy questionnaires developed by WHO.[11]

Laboratory procedures

Maternal samples were tested for HIV-1 antibody using AniLabsytems EIA kit (AniLabsystems Ltd, OyToilette 3, FIN-01720) with all positive specimens confirmed using Enzygnost Anti-HIV 1/2 Plus ELISA and discrepant results resolved by Western Blot. We tested the samples of infants born to HIV-positive mothers and to mothers whose sample was unavailable; infant samples were tested for HIV with DNA polymerase chain reaction (Roche Amplicor HIV-1 DNA Test 1.5).

Indicators and outcomes

Primary outcomes—We estimated two outcomes:

1. HIV-free infant survival (CA-level proportion of infants 9–18 months of age who were born to HIV-infected mothers and who were alive and HIV-uninfected): The denominator (number of HIV-infected mothers) was assessed based on either i) laboratory-confirmed HIV test results (99.4% and 98.7% of the samples in 2012 and 2014, respectively), ii) verbal autopsy data (for deceased mothers, 0.3% and 1% of the samples in 2012 and 2014, respectively), or iii) information recorded on maternal health cards (for deceased or unavailable mothers, 0.3% in each survey). To classify maternal deaths as due to AIDS from verbal autopsy data, we used an algorithm validated in Zimbabwe.[12] The numerator (number of living HIV-uninfected infants) was assessed based on i) laboratory-confirmed HIV test results (97.7% and 99.4% of the samples in 2012 and 2014, respectively), ii) information recorded on infant health cards (1.8% and 0.5% of samples in 2012 and 2014,

respectively), and iii) reports of infants' deaths (0.5% and 0.1% of samples in 2012 and 2014, respectively).

2. MTCT (CA-level proportion of infants born to HIV-infected mothers who were HIV-infected at 9–18 months of age) uses the same denominator as HIV-free infant survival. The numerator (number of infants HIV-infected or deceased related to HIV/AIDS) was assessed based on i) laboratory-confirmed HIV test results (98.1% and 99.5% of the samples in 2012 and 2014, respectively), ii) verbal autopsy data (for deceased infants, 1.3% and 0.2% of the 2012 and 2014 samples, respectively), and iii) information recorded on infant health cards (0.6% and 0.3% of the 2012 and 2014 samples, respectively). A Zimbabwean pediatrician (HAM) examined the infant verbal autopsy data and rated the likelihood of each death being HIV-related (on a 5-point scale ranging between 'very unlikely' and 'very likely') based on: gestational age at delivery, birth weight, infant age at death, symptoms indicative of common opportunistic infections in children, chronicity of their illness, and factors that affect likelihood of MTCT. 'Likely' and 'very likely' cases were classified as infant HIV/AIDS-related deaths.

Timing of Option A implementation—CAs were assigned the Option A implementation date of their corresponding facility. Length of implementation was measured by months since Option A implementation at the local facility at the 2014 survey (minus infants' mean age).

Statistical analysis

Objective 1—We assessed Option A impact by estimating the differences in CA-level MTCT and HIV-free infant survival at 9–18 months. Because we were interested in the population effect of Option A implemented at facility-level, we conducted CA-level analysis (rather than individual-level analysis), consistent with the study design and power calculations. We calculated CA-level MTCT and HIV-free infant survival at both time points, and used a paired t-test to estimate the mean change in these unadjusted proportions in each CA between the 2012 and the 2014 surveys. Although the order in which communities were surveyed in 2012 was timed to maximize the likelihood that all participating infants were born before rollout of Option A, in some CAs Option A had been implemented before eligible infants were born (see Figure, Appendix). We excluded these CAs from the analysis, specifically CAs where Option A was implemented before the mean birthdate of infants surveyed in 2012, and one additional CA where the timing of Option A rollout was unavailable.

We also estimated the number of infant HIV infections averted due to Option A, using maternal prevalence and MTCT rates. Firstly, we estimated infant infections averted compared to the lack of any PMTCT regimen, by subtracting the number of infections in 2014 from the estimated number of infections in the absence of PMTCT (assuming 35% MTCT).[5] Secondly, we estimated infant infections averted compared to pre-Option A levels, by subtracting the number of infections in 2014 from the number of infections at Option A baseline (applying the MTCT rate in the 2012 survey). All estimates of infant

infections were calculated assuming maternal HIV prevalence rates from our evaluation and the number of pregnant women in Zimbabwe from MOHCW.

Objective 2—We examined whether the length of exposure to Option A in each CA was associated with a difference in CA-level HIV-free survival. First, we examined the number of months that Option A had been implemented in each CA and its bivariate-level association with the CA-level HIV-free survival at endline using ANOVA. We also examined this association at the multivariate level using a generalized linear model with a logit link controlling for HIV-free survival at baseline, urban vs. rural CA, number of health staff, number of days per week the facility is open for ANC, the proportion of staff that received training on Option A, and whether the facility had on site CD4 testing at baseline. Of the characteristics initially examined, we excluded some highly correlated variables (estimated population, number of rooms in facility, number of HIV-infected mothers, maternal HIV prevalence).

The data were analyzed in STATA 12 and SAS 9.4 and all data were weighted to adjust for differences in the sampling fraction of CAs within districts.

Sample size calculation

Our sample size was determined to detect a reduction in the CA-level proportion of HIV-exposed infants who either died or became infected with HIV (our primary outcome) from 25% (22–30%)[13] to 18.75%, assuming an estimated HIV prevalence in 16–49 years old pregnant women of 16%.[14] Our estimates assumed 95% significance and 80% power, and were rounded up to the nearest integer. In the absence of reliable data on the coefficient of variation for MTCT by CA in this population, a conservative value of 0.25 was assumed.[15] Initially, assuming a response rate of 90%, we estimated that we would need to sample 157 CAs to achieve the required sample of 7,800 mother-infant pairs. Maternal HIV prevalence and MTCT were both lower than expected in the 2012 survey. Thus, for the 2014 survey, we recalculated the necessary sample using the same 157 CAs with 80% power to detect a difference to below 5% MTCT (the targeted value for Zimbabwe), and we increased the sampling fraction to maintain a harmonic mean of at least 4 HIV-exposed infants per CA.

In the 2012 survey we used the following sampling fractions: 1) 1 in 4 eligible infants in CAs with >300 eligible infants, 2) 1 in 2 in CAs with 150–300 eligible infants, or 3) all eligible infants in CAs with <150 eligible infants. In 2014, the sampling fractions were revised: 1) 1 in 5 in CAs with >300 eligible pairs, 2) 1 in 4 in CAs with 250–300 eligible pairs, 3) 1 in 3 in CAs with 180–249 eligible pairs, 4) 1 in 2 in CAs with 120–180 eligible pairs, or 5) all eligible pairs in CAs with <120 eligible pairs.

Human subjects protection

The Medical Research Council of Zimbabwe and the ethics committees of University of California, Berkeley and University College London approved the study protocol. All participants provided written informed consent and were compensated for their time with a gift worth $5. The bio-behavioral data collected in 2012 was anonymous; participants retrieved their anonymous HIV test results at the local facility up to 3 months following the

survey, using a card with barcode numbers. In 2014, participants who wanted to receive their HIV test results had to provide identifying information to allow personal identification upon receipt of HIV test results at the local facility.

RESULTS

There were 132 CAs classified as unexposed to Option A in the 2012 baseline survey; 7,683 mother-infant pairs participated in the 2012 survey and 9,283 in the 2014 survey. Response rate was high: 97.4% for maternal blood samples in 2012 and 95.3% in 2014, and 96.5% for infant blood samples in 2012 and 93.5% in 2014. We were able to determine the HIV status for 7,249 mothers in 2012 and 8,551 mothers in 2014; of these, 887 (12.2%) and 1,160 (13.6%) were HIV-infected, respectively.

In 2012 we found an average of 6.5 HIV-exposed infants per CA, of whom an average of 0.6 infants were HIV-infected and an average of 6.0 infants were alive and HIV-uninfected (Table 1). Thus, in 2012 the mean CA-level MTCT rate was 10% and the mean CA-level HIV-free infant survival was 89.6%. In 2014, in the same 132 CAs we found an average of 8.6 HIV-exposed infants, of whom an average of 0.5 infants were HIV-infected and an average of 8.2 infants were alive and HIV-uninfected. Hence, in 2014 the mean CA-level MTCT rate was 4.8% and the mean CA-level HIV-free infant survival was 95.1%.

The mean difference in the CA-level MTCT rate at 9–18 months between 2014 and 2012 was −5.2 percentage points (95% confidence interval (CI)= −8.1, −2.3, $p<0.001$), representing a 52% reduction (Table 2). The mean difference in the CA-level HIV-free infant survival at 9–18 months between 2014 and 2012 was 5.5 percentage points (95%CI= 2.6, 8.5, $p<0.001$), representing a 6% increase in HIV-free survival. Between 2012 and 2014, we estimated that 31,185 infant HIV infections were averted by Option A compared to the absence of any PMTCT regimen; 1,779 infections were averted by Option A compared to the pre-Option A regimen.

At the time of the 2014 survey, the median time since Option A implementation was 36 months (range: 26–40); thus, the median *duration* of Option A implementation when the survey infants were born was 24 months. HIV-free infant survival was marginally associated with duration of Option A implementation at the bivariate level ($p=0.025$); this association remained slightly positive but not significant after controlling for population and facility characteristics ($p=0.093$, Table 3). Among covariates, the only statistically significant variable was urban/rural status, with rural CAs experiencing slightly higher HIV-free survival than urban CAs (regression coefficient=−0.10, 95%CI: −0.19, −0.01, $p=0.037$).

DISCUSSION

We conducted an impact evaluation of Option A of the 2010 WHO guidelines in Zimbabwe, a UNAIDS priority country; two years after Option A rollout, we found significantly decreased MTCT and significantly increased HIV-free infant survival at 9–18 months. Introduction of Option A resulted in almost 1,800 HIV infant infections being averted. This is the first and only IE of Option A and shows that Option A has appreciable impact at scale. The data also indicate Zimbabwe's remarkable progress towards eMTCT, despite

challenging political and economical conditions. The duration of Option A implementation (median 36, range 26–40 months) was not associated with CA-level HIV-free survival after controlling for population and facility characteristics.

The efficacy of the PMTCT regimens recommended by the 2010–2013 WHO guidelines has been established.[2] However, little is known about their population effectiveness, especially at scale. To our knowledge these are the first findings from a large-scale IE of the recent WHO guidelines for PMTCT in developing countries and the first IE of Option A. Only one IE of the current WHO guidelines has thus far been conducted and showed increased HIV-free survival at 24 months in Zambia, from 66% at baseline to 89% post-Option B (adjusted hazard ratio 0.52).[16] However, the Zambian evaluation was small scale and assessed a pilot program implementing Option B in four facilities. National-level assessments of the recent WHO guidelines are underway in Rwanda (Option B),[17] Malawi (Option B+),[18] and South Africa,[19] however only the baseline estimates of these evaluations have been published so far.[17–19]

Our study consisted of two serial cross-sectional community-based serosurveys of mother-infant pairs. This study design, initially used in the four-country PEARL study[20], has also been used in the above-mentioned Zambian[16] and Rwandan[17] evaluations. In contrast, the Malawian and South African assessments consist of serial cross-sectional serosurveys of mother-infant pairs attending childhood immunizations,[18,19] which can only estimate early MTCT (<3 months) because they do not account for breastfeeding-related transmission. Community-based surveys such as ours are able to: assess both MTCT and HIV-free infant survival; include all mother-infant pairs, not just those who use health facilities; and account for HIV infections occurring through breastfeeding (e.g., we assessed these outcomes at 9–18 months of age, the Zambian and Rwandan evaluations assessed outcomes at 24 months).[16,17]

The rapid rollout of Option A in Zimbabwe precluded the use of a randomized IE. We responded to this challenge by estimating the overall impact of the intervention by comparing pre- and post-intervention samples; and capitalizing on naturally occurring variability in the duration of CA-level exposure to Option A to examine impact heterogeneity. However, our analysis were unable to account for community-level confounders that might have affected both the exposure to the Option A activities and the probability of vertical transmission of HIV (e.g., changes in transportation infrastructure), as such data were not available. Further, we used a pre-post design and assumed that differences in the unadjusted proportions of MTCT and HIV-free infant survival at 9–18 months between 2012 and 2014 were likely due to Option A. Although Option A is likely the major driver of the significant differences observed, there could be other unmeasured temporal factors such as epidemic trajectory, or other social or health system factors that could influence these outcomes. Nonetheless, several observed factors were examined and found not to be confounders: number of health staff, staff trained in Option A, and availability of CD4 testing.

Our estimates account for transmissions occurring during the first 9–18 months of breastfeeding, however 71% of HIV-exposed infants were still breastfeeding at the time of

the 2012 survey and 78% in 2014 (median duration of breastfeeding in Zimbabwe is 17.8 months[21]). Thus, HIV-free survival at 24 months (at the end of breastfeeding) could be lower, and MTCT might be higher. This is particularly relevant for the 2012 estimates, because before the implementation of Option A, breastfeeding HIV-infected women did not receive ARVs, in contrast to Option A where these women continue receiving prophylaxis until the end of breastfeeding. Further, despite our efforts to enroll all eligible mother-infant pairs and to include verbal autopsy data, infant deaths may have been underreported. Moreover, maternal HIV status was measured at 9–18 months postpartum; however, some HIV-positive women might have become infected postpartum (assuming 2.9 per 100 woman-years incidence postpartum,[22] approximately 22 of 887 HIV-infected women at baseline and 34 of 1,160 at endline) and may have (appropriately) not received ARV prophylaxis. Finally, data were only collected in five of ten provinces (where 55% of the population of Zimbabwe live),[23] although these were widely dispersed across the country and included major cities.

We assessed the population-level effect of Option A on MTCT and HIV-free infant survival at 9–18 months in Zimbabwe. Our findings support the impact of Option A, by demonstrating that this PMTCT regimen can be effective in a real-world setting. Moreover, the 2014 survey data presented here provide baseline estimates for estimating the impact of Option B+, which has been recently rolled out in Zimbabwe. A third cross-sectional survey will be conducted in 2017 in the same 157 catchment areas surveyed in 2012 and 2014, to obtain endline estimates of HIV-free infant survival and MTCT after two years of implementation of Option B+. This will provide a unique opportunity to compare the effectiveness of Options A and B+ in the same setting.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

RB and MKD conducted the analysis. RB prepared the first draft of the manuscript, in collaboration with MKD. NP, FC and SM designed the study and provided substantial contributions to the manuscript. CW coordinated all data collection activities and JD oversaw the data management activities. MKD developed the survey weights and HAM analyzed the infant verbal autopsy data. Angela M, Agnes M, AH, OM and RAK were instrumental in the design of the study. All authors contributed to the manuscript and approved the final draft.

We thank our many collaborators who were instrumental in the design and implementation of this large-scale study, including Maya Petersen, Tyler Martz, Tim Buisker from the University of California, Berkeley, Reuben Musarandega and Batsirai Chikwinya from EGPAF Zimbabwe, Laura Guay and Nick Hellmann from EGPAF, and KudaMutasa and Sekesai Zinyowera from the National Microbiology Reference Laboratory in Zimbabwe. We also thank our participants without whom this study would not have been possible.

SOURCE OF FUNDING: The study was funded by the Children's Investment Fund Foundation and the National Institutes of Health.

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Appendix

Table

Characteristics of selected catchment areas and health facilities, and mean HIV-free infant survival (based on the 2014 survey) across these characteristics; data from the impact evaluation of Zimbabwe's PMTCT program.

Characteristic	N	%	Mean HIV-free survival	p value[a]
Catchment area (CA) characteristics				
Estimated population in CA				
<5,000 people	33	25	92.3%	0.423
5,000–9,999 people	46	35	92.2%	
10,000–14,999 people	30	23	92.5%	
15,000+ people	15	11	91.9%	
Don't know	8	6	92.1%	
Type of CA				
Rural	112	85	92.3%	0.012
Urban	20	15	91.7%	
Prevalence of HIV among mothers in the CA				
Less than 12%	71	54	92.2%	0.818
12% or higher	61	46	92.3%	
Facility characteristics				
Volume of HIV positive moms seen				
Less than 5	65	49	92.2%	0.391
5 or more	67	51	92.3%	
Number of rooms in health facility				
1 to 5	31	23	92.0%	0.176
6 to 8	42	32	92.3%	
9 to 11	31	23	92.6%	
12+	17	13	92.0%	
unknown	11	8		
Number of staff members in facility (except village health workers)				
<5	30	23	92.3%	0.970
5–6	48	36	92.3%	
7–10	22	17	92.2%	
>10	29	22	92.2%	
Don't know	3	2		
Number of village health workers/health promoters				
<5	50	38	92.1%	0.530
5–6	22	17	92.6%	

Characteristic	N	%	Mean HIV-free survival	p value[a]
7–10	13	10	92.2%	
>10	41	31	92.3%	
Don't know	6	5		
How many days per week open for ANC				
1	9	7	92.0%	0.068
2	9	7	91.7%	
3	2	2	91.6%	
4	3	2	91.4%	
5	61	46	92.3%	
6	9	7	93.2%	
7	39	30	92.2%	
Staff received training on Option A				
Yes, 50% or more of staff trained	61	46	92.2%	0.949
Yes, less than half of the staff trained	66	50	92.3%	
No or don't know	5	4	92.0%	
Facility had on site CD4 testing at baseline				
Yes	28	21	92.3%	0.872
No	104	79	92.2%	

CA=catchment area

[a] p value of ANOVA test

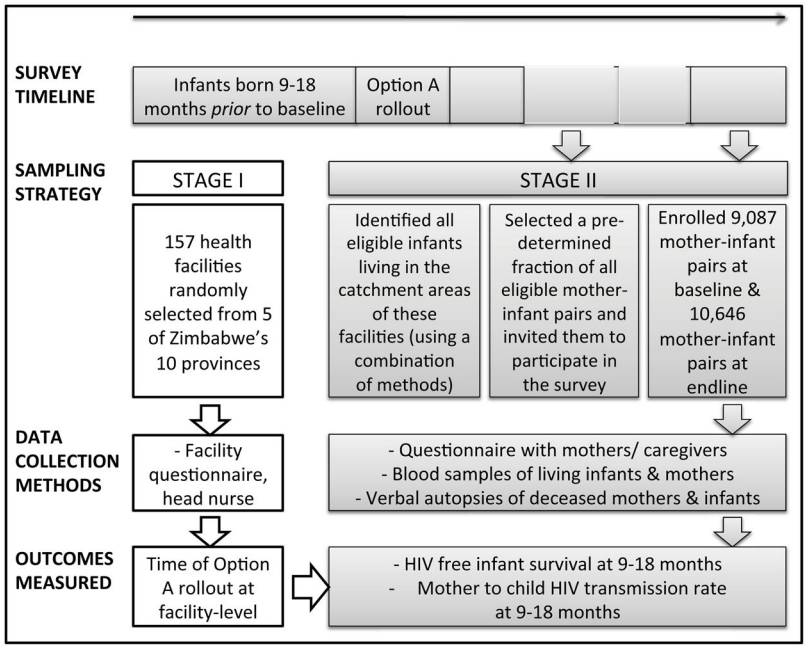

Figure 1.

Survey timeline, sampling strategy, data collection methods and outcomes measured for the 2012 and 2014 surveys of the impact assessment of Zimbabwe's PMTCT program based on Option A of the 2010 WHO guidelines

Table 1

Calculation of weighted estimates of catchment area-level MTCT and HIV-free infant survival at 9–18 months, by survey round; five provinces in Zimbabwe, 2012–14

# Outcome indicator	Survey Round	n	CA-level Mean	SD	Min	Median	Max
(1) Number of HIV-exposed infants per CA	2012	132	6.54	4.94	0	5	32
	2014	132	8.64	6.83	0	7	41
(2) Number of HIV-exposed infants who were HIV-infected per CA	2012	132	0.58	0.76	0	0	3
	2014	132	0.49	0.94	0	0	5
(3) Number of HIV-exposed infants who were alive & HIV-uninfected per CA	2012	132	5.96	4.75	0	5	29
	2014	132	8.15	6.28	0	7	38
(4) MTCT at 9–18 months * = (2)/(1)	2012	128	10.03	14.50	0	0	66.7
	2014	130	4.83	8.55	0	0	50
(5) HIV-free infant survival at 9–18 months = (3)/(1)	2012	128	89.60	14.47	33.3	100	100
	2014	130	95.12	8.59	50	100	100

MTCT = mother-to-child transmission of HIV; SD = standard deviation; Min = minimum value; Max = maximum value

* No MTCT rate was calculated for the catchment areas with 0 HIV-exposed infants (4 catchment areas at baseline, 2 catchment areas at endline).

Table 2

The impact of Zimbabwe's PMTCT program implementing the 2010 WHO Option A guidelines on MTCT and HIV-free infant survival at 9–18 months

	CA-level Mean	95% CI		p value
MTCT at 9–18 months				
Baseline estimate (CA-level aggregate)	10.03	7.50	12.56	
Endline estimate (CA-level aggregate)	4.83	3.35	6.31	
Difference: Endline - Baseline estimate	**−5.19**	−8.13	−2.26	**0.001**
HIV-free infant survival at 9–18 months				
Baseline estimate (CA-level aggregate)	89.60	87.07	92.13	
Endline estimate (CA-level aggregate)	95.12	93.63	96.60	
Difference: Endline - Baseline estimate	**5.51**	2.58	8.45	**<0.001**

MTCT = mother-to-child transmission of HIV; CA=catchment area

Note: Pre-post analysis with the catchment area as the unit of analysis. We calculated weighted CA-level MTCT and HIV-free infant survival at both time points and used a paired t-test to estimate the mean change in these unadjusted proportions in each CA between the 2012 survey and the 2014 survey.

Table 3

Association between endline CA-level HIV-free infant survival at 9–18 months and months since since introduction of Option A; data from the impact evaluation of Zimbabwe's PMTCT program.

	Number of CAs	%	Mean HIV-free infant survival	p value[a]	Regression coefficient	95% CI	p value[b]
Months since introduction of Option A							
14–23 months	63	48	92.0%	0.025	1	-	0.093
24–28 months	69	52	92.5%		0.01	(−0.01,0.02)	

[a] ANOVA test

[b] Generalized linear model of the HIV-free survival at endline with a logit link, among 132 catchment areas (CAs). In addition to months since introduction of Option A, the model controlled for HIV-free survival at baseline and for the following CA-level population and facility characteristics: urban vs. rural catchment area, number of health staff members, number of village health workers/health promoters, number of days per week the facility is open for antenatal care, the proportion of health staff that received training on Option A, and whether the facility had on site CD4 testing at baseline.