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Methods and Baseline Results of a Repeated Cross-Sectional Survey to Assess the Public Health Impact of Antiretroviral Therapy in Lusaka, Zambia

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Abstract. Although the individual-level impact of antiretroviral therapy (ART) is well documented, there are few available data describing the public health impact of services for persons infected with human immunodeficiency virus in resource-constrained settings. We describe the methods and baseline results of a household survey that assessed the population-level impact of the national program for HIV care in Zambia and treatment in the city of Lusaka. The survey was timed with the staggered expansion of services and repeated cross-sectional surveys planned for pre-implementation and post-implementation comparisons made by community. In the initial survey round, which was performed during the early phases of the program (November–December 2004), 18,110 persons were enumerated from 3,600 households surveyed. Respondents were asked questions designed to evaluate community-level mortality and respondent knowledge and attitudes towards HIV. These findings will serve as a reliable reference in the future analysis of the population-level impact of this HIV treatment and care program in Zambia.

INTRODUCTION

Over the past five years, initiatives worldwide have dramatically increased access to long-term care for adults and children infected with human immunodeficiency virus (HIV). Local governments and international donors have demonstrated an unprecedented commitment to expanding coverage for antiretroviral therapy (ART), with more than two million persons now estimated to be receiving treatment in Africa.[1] On an individual level, ART has enabled many ill HIV-infected persons to return to a normal life.[2–7] However, the impact of ART services at the population level has not yet been well-documented in many settings. If treatment coverage for HIV-infected patients cannot be provided and maintained on a sufficient scale relative to the population at risk, individual-level health improvements may not translate to broader population-level reductions in morbidity and mortality.

For these reasons, measurement of population-level effectiveness of ART is critically needed in program evaluation, particularly in settings of rapid scale-up. In developed countries, vital registration data and surveillance systems have provided evidence that mortality rates have decreased as access to ART has improved.[8] Although such comprehensive data are not available in most resource-poor countries, results from the few completed studies have been encouraging. For example, results from a demographic surveillance study in Malawi suggested that the introduction of ART over a 10-month period led to a 10% reduction in adult mortality attributable to acquired immunodeficiency syndrome (AIDS).[9] Although these studies provide evidence of a population-level reduction in mortality resulting from ART programs, they are limited by the length of their follow-up time post-implementation. A longer evaluation period is needed to determine if these population-level reductions in mortality are sustainable.

In Zambia, the national program for HIV care and treatment has expanded rapidly across the country since 2004. In the capital of Lusaka, more the 134,000 patients have enrolled in long-term care and more than 84,000 have started receiving ART as of November 2009.[5,10] In an effort to measure the impact of ART service expansion at the community level, we conducted a series of cross-sectional household surveys across Lusaka, which were timed according to program implementation. This project was designed to evaluate whether clinic-level services for HIV care and treatment would positively impact the surrounding communities through reduced population-level mortality, improved knowledge and attitudes towards HIV, and improved knowledge and attitudes related to antiretroviral drugs. In this paper, we report our study methods and key findings from the initial survey round (November–December 2004).

MATERIALS AND METHODS

Setting. Lusaka, which has a total population of 1.1 million persons,[11] is served by a network of 24 public-sector primary health centers managed by a district-level health office. Most residents of Lusaka use these clinics for their health care. Each of the 24 clinics has a predefined catchment area based upon proximity to the respective clinics. Persons are free to attend any public facility, but most patients reportedly visit the clinic serving their catchment area. Administratively, these catchment areas are composed of standard enumeration areas (SEAs) designated by the Central Statistical Office, the equivalent to the U.S. Census Bureau. The number of SEAs and households in each catchment area varies from community to community. A list of all clinics with their estimated catchment area sizes is shown in Table 1.

In Lusaka, services for HIV care and treatment were implemented in April 2004 and by November 2008 had expanded to 16 sites. The clinical care provided at these sites is standardized and has been described elsewhere.[5,10] Implementation was staggered for logistical reasons and the order of selected clinics was based on geographic location, existing clinical infrastructure, and size of catchment population. Expansion was likewise strategic to meet Zambian Ministry of Health priorities for equitable and rapid expansion.

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TABLE 1
Characteristics of the sampled catchment areas and corresponding district health facilities in Lusaka, Zambia, 2004*

District health facility	Population	Households	SEAs	Date clinic started providing antiretroviral therapy	Distribution of where respondents access care, %		
					Same district clinic as assigned catchment area	Different district clinic than assigned catchment area	Other clinic (private, university, military)
Bauleni	22,491	4,892	30	Dec 2004	92.0	6.0	2.0
Chainama	33,475	7,455	39	–	64.4	18.1	17.4
Chainda	25,059	5,665	39	–	91.3	6.0	2.7
Chawama	57,854	12,367	60	Mar 2006	93.3	3.3	3.3
Chazanga	21,822	4,753	41	–	52.0	34.0	14.0
Chelstone	22,416	4,787	27	Apr 2004	82.8	1.3	15.9
Chilenje	36,520	6,565	37	Sep 2004	88.0	2.0	10.0
Chipata	48,158	10,621	59	Feb 2005	94.7	1.3	4.0
Civic Center	22,278	5,002	27	–	48.0	4.7	47.3
George	50,610	11,116	57	Aug 2004	92.0	3.3	4.7
Kabwata	26,022	5,300	30	Mar 2006	58.7	6.7	34.7
Kalingalinga	37,748	6,863	32	Apr 2004	83.3	6.7	10.0
Kamwala	12,919	2,557	13	Apr 2004	74.0	13.3	12.7
Kanyama	73,313	20,459	105	Apr 2004	62.0	34.0	4.0
Kaunda Square	29,041	5,492	23	–	55.6	37.7	6.6
Lilayi	34,424	7,470	47	–	12.0	82.0	6.0
Makeni	9,995	2,701	8	Mar 2007	59.7	17.4	22.8
Mandevu	39,216	8,643	40	–	9.3	78.7	12.0
Matero Main	18,071	3,347	22	Aug 2006	19.9	68.9	11.3
Matero Ref	33,038	6,713	39	Apr 2004	90.0	4.0	6.0
Mtendere	55,244	13,150	72	Apr 2004	76.0	17.3	6.7
Ngombe	36,060	8,555	42	Mar 2007	90.7	6.0	3.3
Railway	20,325	5,713	25	May 2008	26.8	14.8	58.4
State Lodge	4,952	1,283	7	–	36.0	52.0	12.0

*SEAs = standard enumeration areas.

Survey design and sampling. This phased approach to program expansion in Lusaka lends itself to evaluation through repeat cross-sectional surveys, a design that approximates the stepped wedge approach described in the epidemiologic literature.[12] Overlaying this study framework upon the staggered implementation of services enables a comparison of pre-implementation and post-implementation sites at the time of each survey and site comparisons across multiple surveys. We thus proposed a series of cross-sectional surveys to be carried out across all communities simultaneously, regardless of whether services had yet been implemented. The initial round of this study, for which we report findings, was conducted during November–December 2004.

We define our population of interest for this study as the residents of Lusaka, Zambia. Every round, 3,600 households are sampled to be equally representative of each community. By aggregating responses from these individual informants, we can assess the population-level impact by tabulating an outcome of interest for a given catchment area at a given time and compare results with other communities or within the same community across time. Based on the predefined catchment areas for each district clinic, three SEAs corresponding to each of the 24 communities are randomly sampled with probability proportional to size. These SEAs are independently selected at the Central Statistical Office in Lusaka. Within each of the 72 SEAs selected, 50 households are selected by applying a fixed sampling interval. Every xth house in the SEA is selected, where x is the number of households in the SEA divided by the number of households to be sampled in that SEA. A replacement home is chosen in the same area if any of the following conditions were present: no one is home after three follow-up visits, an eligible participant is not identified, or the prospective participant refuses. The same randomization procedure is used in subsequent rounds and results in a resampling of the SEAs and corresponding households each time.

In other similar studies, investigators have elected to repeatedly visit the same households over the study period.[13,14] For this study, we chose a cross-sectional approach to sample different households each round. An obvious advantage to this approach is convenience; specific households do not need to be tracked and followed over time. It also reduces the influence of the survey interview on reported knowledge, attitudes, and perceptions. For example, if the same cohort was surveyed in subsequent surveys, familiarity with the questions could result in an increase in knowledge that may not be representative of the entire population. However, a recognized limitation of this design is the lack of validation to the reporting of household mortality. With no historical information regarding household residents during previous years, the cross-sectional design relies solely on respondent recall.

Questionnaire design. Our study questionnaire is adapted from the Demographic and Health Survey in Zambia, which has been regularly conducted every 4–5 years since 1992.[15] Prior to implementation, the questionnaire was field tested by a pilot study in July 2004. This preliminary survey was administered to 4,200 households, enabling the investigators to gain participant and administrator feedback. An evaluation of participant responses highlighted questions that were unclear and needed revision. Other questions not pertinent to the objectives of the study were removed. The questionnaire is developed in English, but is also translated into Bemba and Nyanja, the two most widely spoken local languages in Lusaka.

Demographic characteristics. Survey participants are asked a series of questions regarding the social and economic conditions of household members, including age, sex, and relationship to head of household. In addition, we collect data regarding access to health services. We ask participants to state which clinic they would likely attend in the event they were to become ill as a means to validate our catchment area

assumptions about specific SEAs. The response is open-ended to enable the participant to select any location, including private clinics.

Mortality. We assess mortality rates by asking respondents about vital events in their households over the past year. Respondents are first asked to identify all persons who have lived in the household over the past 12 months, and then identify those who died over this period. The mortality rate is then calculated from these figures. Separate mortality rates are calculated for pre-defined age and sex categories; the adult mortality rate is calculated using household members between the ages of 15 and 49 years.

Knowledge and attitudes of respondent regarding HIV. Each respondent is asked a standard battery of questions about HIV to assess general knowledge of the disease. We also poll the respondent's knowledge of available HIV testing options, access to antiretroviral drugs, and sources of educational information. Because of the sensitivity surrounding HIV status, the questions are phrased in a manner that avoided individual disclosure of HIV serostatus.

Data collection. Each survey round is conducted by approximately 20 staff members. Each undergoes an intensive three-day training program prior to the beginning of each survey round. The surveyors are divided into teams of four interviewers led by one supervisor. The first household to be surveyed in a given SEA is determined by the spin of a bottle. The surveyors then visited subsequent houses using the fixed sampling interval described previously.

When the interviewers arrived at a housing unit, they ask for the person who normally makes day-to-day decisions regarding the household. This head of the household can be either male or female. However, priority was given to females because they are thought to be more knowledgeable about the health status of all family members. If no head of household was available, the interviewer returns up to three more times. These return visits normally take place either the same day or the following day. If follow-up visits remain unsuccessful, a replacement household is selected.

Potential survey participants are given information about the evaluation and informed consent is obtained prior to initiating the survey. Household data is collected on paper forms and entered in EPI-INFO version 6 (Centers for Disease Control and Prevention, Atlanta, GA). Automatic logic checks are incorporated to reduce internal inconsistencies.

Statistical analysis. We analyzed the responses from the initial survey of this study to provide baseline results. The first round of the Lusaka survey was conducted between November 11 and December 8, 2004. Unweighted mortality rates from the first round of data collection were calculated in person-years and corresponding exact Poisson confidence intervals were generated for each estimate. Mortality rates that were proportionally weighted for each catchment area by the number of SEAs were calculated in a similar fashion. Within the predefined catchment areas, descriptive statistics were tabulated for selected questions. The ranges of responses across all catchment areas and a single point estimate for the aggregated data are reported for each question. Results were further disaggregated based upon whether the household corresponded to a catchment area where ART services had been available for greater than six months. All statistical analyses were performed using SAS version 9.1.3 (SAS Institute, Cary, NC). This study was reviewed and approved by the Institutional Review Boards of the University of Zambia and the University of Alabama at Birmingham. Each study respondent was above the age of legal majority in Zambia and provided written informed consent prior to participating.

RESULTS

Of 3,600 households targeted for interviewing during this initial round, 248 (7%) did not participate: 47 had no one available during repeated attempts, 133 did not have any eligible participants, 61 refused, and 7 cited other reasons. These households were replaced as described previously. When asked to report where they would most likely seek medical care, 2,330 (65%) of 3,600 household respondents identified the district clinic corresponding to the catchment area sampling frame, 779 (22%) selected a district clinic outside the catchment area, and 491 (14%) designated a facility outside of the public health sector (e.g., private clinic, military hospital).

Demographic characteristics. Most surveys (n = 2,641, 73%) were administered in either Bemba or Nyanja; the remainder were conducted in English. Of 3,600 surveyed households, 2,319 (64%) were located in low-cost areas as defined by the Central Statistical Office classification list. Respondents were predominantly female (86%) with a median age of 30 years (interquartile range [IQR] = 25–39 years). Additional demographic information regarding the respondents are shown in Table 2. A total of 18,110 people lived in the 3,600 enumerated households over the 12 months prior to our baseline survey, with an average of 5.03 per household. The distribution of household members by age and sex is shown in Figure 1A. The median age of the household residents was 19 years (IQR = 8–30 years).

Mortality in the past 12 months. Of the 18,110 household members enumerated, 256 deaths were reported. Of these deaths, 141 (55%) were females and 141 (55%) were adults between the ages of 15 and 49 years. The median age of persons who died was 27 years (IQR = 6–38 years). The distribution of recorded deaths by age and sex is shown in Figure 1B. The overall mortality rate for all members of a household was 1.40 (95% confidence interval [CI] = 1.24–1.59) deaths per 100 person-years. Similarly, the weighted overall mortality rate was 1.49 (95% CI = 1.30–1.66) deaths per 100 person-years. The mortality rates for children less than five years of age and those 5–14 years of age were 2.35 (95% CI = 1.79–3.04) and 0.47 (95% CI = 0.30–0.70) deaths per 100 person-years, respectively. The adult mortality rate was 1.41 (95% CI = 1.19–1.66) deaths per 100 person-years and 3.74 deaths per 100 person-years (95% CI = 2.52–5.34) for those more than 50 years of age. Respondents were also asked to self-report the cause of death; the most common listed causes were tuberculosis (63), malaria (39), and diarrhea (18). Only five household respondents indicated AIDS as the primary cause of death.

Knowledge and attitudes regarding HIV. Of 3,600 respondents, 3,598 (> 99%) had heard of HIV and 3,525 (98%) were aware that there were precautionary measures that could be taken to avoid AIDS. The proportion of persons who could correctly identify the two major ways of preventing the sexual transmission of HIV (using condoms and limiting sex to one faithful, uninfected partner) was 79%. The proportion was identical in the subset of respondents residing in catchment areas where ART services had been available for more

TABLE 2
Demographic characteristics of 3,600 survey respondents in Lusaka, Zambia, 2004*

Characteristic	No.	Value†	Range†
Sex			
Female	3,109	86.4	(69.8–94.7)
Male	491	13.6	(5.3–30.2)
Age in years, median (IQR)	36	30 (25–39)	(28–40)
Married or living with partner	2,708	75.2	(56.7–85.3)
Birth control (respondent or respondent's partner doing something to avoid a pregnancy)			
None	1,445	40.1	(30.7–46.0)
Yes	1,907	53.0	(45.3–62.7)
Currently pregnant	248	6.9	(3.3–12.0)
Pregnant (or partner pregnant) in last 12 months	472	13.1	(6.0–25.3)
Received antenatal care during last pregnancy	466	98.7	(88.9–100.0)
Type of household			
High cost area	606	16.8	(0.0–100.0)
Medium cost area	675	18.8	(0.0–100.0)
Low cost area	2,319	64.4	(0.0–100.0)
Enough food in the household			
Always	1,678	46.6	(19.3–94.0)
Sometimes	1,649	45.8	(6.0–66.0)
Seldom/never	273	7.6	(0.0–16.7)
Language of choice for interview			
Bemba	664	18.4	(4.7–34.7)
Nyanja	1,977	54.9	(3.3–80.7)
English	959	26.6	(2.0–92.0)
Denied medical care because could not pay?	483	13.4	(2.0–33.3)
People living in household because their own households could not cater for them?	477	13.3	(6.7–25.3)

* IQR = interquartile range. Separate summary measures for all variables were calculated for each catchment area. The range column lists the smallest and largest values calculated at all sites.
† Values are percentages unless otherwise indicated.

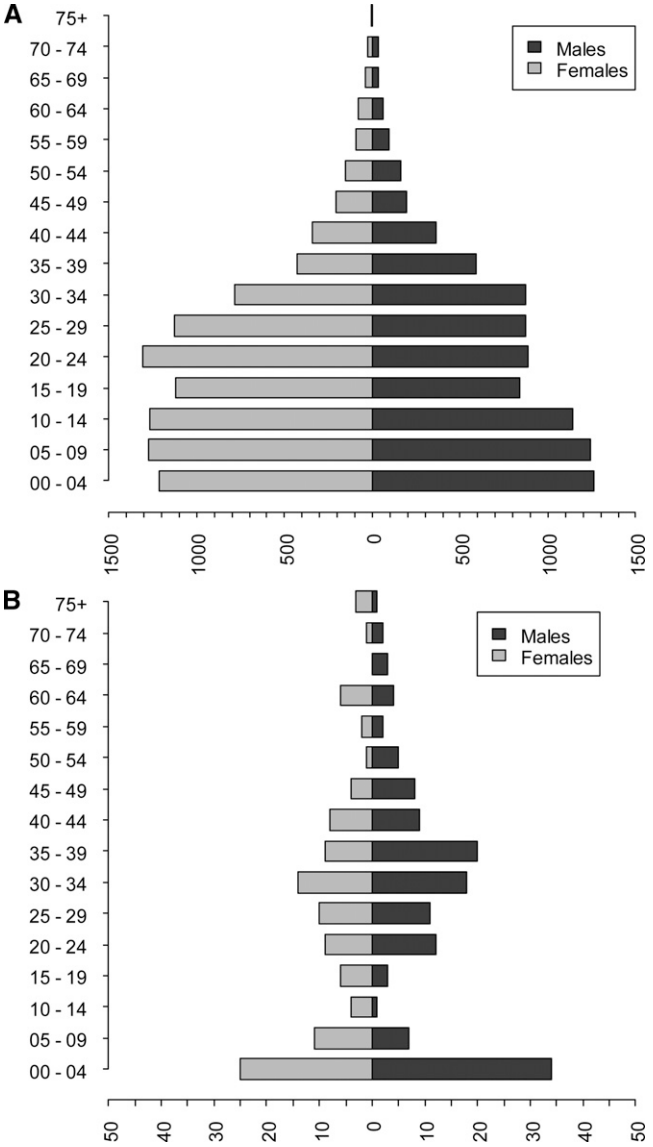

FIGURE 1. **A**, Age distribution of 18,110 household members reported by survey respondents and **B**, age distribution of 256 household deaths reported by survey respondents in Lusaka, Zambia, 2004.

than six months. Respondents were also asked questions to gauge their perception of the disease. Half did not think that a healthy looking person could have HIV and two of every three respondents perceived their own risk of acquiring HIV to be minimal or nonexistent. Questions pertaining to stigma showed that 1,296 (36%) believed that AIDS was a punishment from God for being promiscuous and 876 (24%) would prefer to keep an HIV infection secret if a member of their family became infected.

Overall, 2,012 (56%) respondents indicated they had either previously visited a voluntary counseling and testing center or been counseled as part of antenatal care. The self-reported rate of ever being tested for HIV was 42%, and 1,455 (40%) said they knew their own HIV serostatus; respondents were not queried about their actual status. Although more than 70% of respondents had heard of antiretroviral drugs, only one-third was specifically aware of a location to access them for free. In the catchment areas where ART services had been available for more than six months, 76% of respondents had heard of antiretroviral drugs and 38% knew where to access them. Additional survey responses are shown in Tables 3 and 4.

DISCUSSION

Numerous programs have demonstrated the feasibility of HIV care and treatment programs in resource-constrained African settings. With overwhelming evidence suggesting the benefits of ART programs on an individual level, it is important to investigate whether the benefits transition into detectable long-term community-level effects. Results from this initial survey provide important baseline mortality rates as well as an assessment of knowledge and attitudes towards HIV prior to the broader accessibility of services.

Our survey study offers a unique opportunity to investigate temporal trends in community-level mortality after ART program implementation. Investigations of population-level effects of an intervention over time are sometimes restricted from establishing an adequate control. Because the treatment cannot be intentionally withheld, there may only be one opportunity for a pre-intervention control. Our study design takes advantage of the staggered implementation of ART services in Lusaka, an operational necessity, to enable pre-intervention and post-intervention comparisons and temporal comparisons across ART and non-ART sites. By using a

TABLE 3
Human immunodeficiency virus–related knowledge among 3,600 survey respondents in Lusaka, Zambia, 2004*

Characteristic	All sites (n = 24), % of yes responses (range)	Pre-implementation sites (n = 20), % of yes responses (range)	Post-implementation sites (n = 4), % of yes responses (range)
HIV knowledge			
Have you ever heard of a disease called HIV/AIDS?	99.9 (99.3–100.0)	100.0 (99.3–100.0)	99.8 (99.3–100.0)
Is there anything a person can do to avoid getting AIDS or the virus that causes AIDS?	97.9 (94.7–100.0)	98.0 (96.0–100.0)	97.7 (94.7–99.3)
Is there anything that can be done to reduce the chances that a mother would transmit the AIDS virus to her child?	77.8 (68.7–88.7)	77.6 (68.7–88.7)	79.0 (74.0–88.7)
Can people reduce their chances of getting the AIDS virus by using a condom every time they have sex?	79.6 (64.7–92.7)	79.8 (64.7–92.7)	79.0 (72.7–89.3)
Can people reduce their risk of getting infected with the AIDS virus by having one uninfected faithful sexual partner?	98.6 (94.0–100.0)	98.6 (94.0–100.0)	98.5 (97.3–100.0)
Correctly identify the two major ways of preventing the sexual transmission of HIV (using condoms and limiting sex to one faithful, uninfected partner)	79.0 (64.7–92.0)	79.1 (64.7–92.0)	78.5 (72.0–89.3)
Do you think there is a cure for HIV/AIDS?	7.1 (2.7–13.3)	6.8 (2.7–13.3)	8.5 (6.0–11.3)
Is there anything that people who are infected with HIV or have AIDS can do to stay healthy?	94.6 (82.7–100.0)	94.4 (82.7–100.0)	95.2 (90.0–97.3)
Can a healthy looking person have HIV?	52.3 (29.3–78.7)	52.0 (29.3–78.7)	54.2 (37.3–74.7)
Based on your sexual experience, how likely do you think it is that you are at risk of having contracted HIV/AIDS?			
No risk or small risk	64.3 (51.3–76.0)	64.0 (51.3–76.0)	65.5 (59.3–74.7)
Moderate risk or high risk	22.7 (14.0–34.0)	22.8 (14.0–34.0)	22.2 (18.0–29.3)
Do not know	13.1 (4.0– 23.3)	13.2 (4.7–23.3)	12.3 (4.0–20.0)
Experience and attitudes towards people living with HIV/AIDS			
Do you personally know anyone who has HIV?	66.9 (50.0–86.0)	66.6 (50.0–86.0)	68.3 (58.7–78.7)
Do you personally know anyone who has died of AIDS?	62.5 (42.0–86.7)	62.2 (42.0–86.7)	64.2 (56.0–79.3)
Do you know anyone amongst your family or friends whom you believe have HIV/AIDS or have died of AIDS?	43.4 (20.7–69.3)	44.1 (20.7–69.3)	40.0 (24.7–52.7)
Do you think HIV/AIDS is a punishment from God for promiscuous people?	36.0 (24.0–47.3)	35.8 (24.0–47.3)	36.8 (30.7–42.7)
Do you think you could recognize someone with AIDS just by looking at her/him?	93.5 (74.0–99.3)	93.2 (74.0–99.3)	95.2 (93.3–97.3)
If a member of your family got infected with the virus that causes AIDS, would you want it to remain a secret or not?	24.3 (9.3–44.7)	24.2 (9.3–44.7)	24.8 (21.3–28.7)
If a relative of yours became sick with the virus that causes AIDS, would you be willing to care for her or him in your own household?	89.4 (77.3–95.3)	89.7 (80.8–95.3)	87.8 (77.3–94.7)

* HIV = human immunodeficiency virus; AIDS = acquired immunodeficiency syndrome. Separate summary measures for all variables were calculated for each catchment area. The range column lists the smallest and largest values calculated at all sites.

cross-sectional sampling scheme rather than repeatedly sampling the same households, our study will enable investigation of changes in HIV knowledge and awareness over time without concerns regarding familiarity biases. By using an identical questionnaire in subsequent rounds, all of the key indicators identified in this initial survey can be measured over time.

The primary outcome for our study is mortality. Our method for determining mortality is based on respondent recall; such an approach has been used in a number of settings, including during war[16] and famine.[17] Alternative indirect approaches relying on sibling mortality data, such as the sisterhood method[18] to estimate maternal mortality, are also widely used. Because our questionnaire was adapted from the Zambian Demographic and Health Survey, it was not surprising that the observed adult mortality rate of 1.4 deaths per 100 person-years was virtually identical to that of the 2001–2002 survey (1.43 deaths per 100 person-years).[15] We find this result reassuring and believe it provides a degree of validation regarding our study implementation. Because the 2001–2002 survey was performed at a time when availability of ART was extremely limited in the public sector, the similarity in mortality rates suggest a baseline measure in late 2004 that was similar to that of the pre-ART era.

Our early data provide a snapshot of the Lusaka population around the time of ART expansion. The survey period in this first round was November–December 2004, just six months after implementation of services at four sites. Many findings were encouraging; at the time when treatment of AIDS was becoming readily available, reported awareness of HIV was nearly universal. The high percentage of respondents who could identify condoms and limiting sex to one partner suggests the population was aware of the behavioral component of HIV transmission. This finding corroborates the results of an HIV sentinel survey also administered in Lusaka, which found that behavioral changes (including consistent condom use, less sexual activity, and fewer sexual partners) were occurring as early as the end of the previous decade.[19] Less encouraging, however, was the population's response to the epidemic; less than half had ever undergone HIV testing. We noted an almost identical testing rate in the subset of respondents residing in the catchment area of one of the four initial sites. The general understanding of treatment options for HIV was also disappointingly low at the time. Despite the availability of free antiretroviral drugs for more than eight months, only one-third of respondents appeared to be aware of the program. Although this awareness level was slightly higher in the areas surrounding the four initial program sites, this difference appeared negligible (38% versus 33%). Success of such rapid scale-up programs on the population level will ultimately depend not just on the availability of services, but also use of services by the target population.

To assess program impact at the community level, our study design is heavily reliant on a direct relationship between where the patients live and where they seek health care. However, when survey respondents were asked to identify where they would go if they required medical treatment, 22% listed a

TABLE 4
Knowledge and attitudes regarding HIV testing and treatment among 3,600 survey respondents in Lusaka, Zambia*

Characteristic	All sites (n = 24), % of yes responses (range)	Pre-implementation sites (n = 20), % of yes responses (range)	Post-implementation sites (n = 4), % of yes responses (range)
Knowledge of testing			
Do you know where a person can go for HIV counseling and testing?	89.6 (74.0–99.3)	88.9 (74.0–99.3)	92.8 (88.0–98.0)
Have you ever visited any VCT center?	28.7 (17.3–39.3)	28.1 (17.3–39.3)	31.7 (28.0–39.3)
Have you ever been counseled about HIV as part of antenatal care?	46.8 (26.0–66.0)	47.0 (26.0–66.0)	45.7 (37.3–56.7)
Have you been counseled by either VCT or antenatal?	55.9 (39.7–68.7)	56.2 (39.7–68.7)	54.3 (48.7–65.3)
Would you be interested in being counseled on HIV/AIDS without going for an actual test?	81.7 (67.8–91.3)	81.8 (67.8–91.3)	81.3 (70.7–88.0)
Would you be interested in getting an HIV test?	68.3 (53.3–78.0)	68.7 (54.3–78.0)	66.3 (53.3–74.7)
I don't want to know the results but have you ever been tested to see if you have HIV?	41.8 (29.8–61.3)	41.5 (29.8–61.3)	43.0 (32.7–59.3)
I don't want you to tell me the results of the test but have you been told the results?	40.4 (25.3–58.0)	40.2 (25.3–58.0)	41.5 (32.0–57.3)
Did you tell anyone about the results of the test?	38.2 (24.7–56.0)	37.9 (24.7–56.0)	39.8 (30.7–56.0)
Knowledge of treatment availability			
Have you ever heard of any free medicines that are available to people who are suffering from HIV/AIDS?	60.1 (36.0–82.6)	59.4 (36.0–82.6)	63.3 (48.7–72.7)
Have you ever heard of ARVs?	70.8 (46.0–97.3)	69.8 (46.0–97.3)	75.5 (50.0–94.0)
Have you ever heard or seen any advertisements about free ARVs?	38.9 (10.0–73.3)	38.7 (10.0–73.3)	39.7 (16.0–58.0)
Have you seen drama groups or community theater about ARVs?	15.0 (2.7–26.0)	15.2 (2.7–26.0)	14.3 (12.7–15.3)
Do you know a place where you can get free ARVs?	33.8 (12.7–65.8)	33.0 (12.7–65.8)	37.7 (22.0–56.0)
Has your household ever been visited by a health worker to discuss free ARVs?	3.5 (0.0–9.3)	3.6 (0.0–9.3)	3.3 (1.3–8.0)
Have you ever received information about how to take ARVs?	11.5 (2.0–34.0)	11.1 (2.0–34.0)	13.3 (9.3–17.3)
Have you ever discussed taking ARVs with anyone?	13.4 (3.3–34.0)	13.3 (3.3–34.0)	13.8 (12.0–16.0)
Has anyone in your household ever received ARVs during pregnancy to prevent mother-to-child transmission of HIV/AIDS?	0.1 (0.0–0.7)	0.1 (0.0–0.7)	0.2 (0.0–0.7)
Has anyone in your household ever received ARVs for treatment outside of pregnancy?	1.2 (0.0–4.7)	1.2 (0.0–4.7)	1.2 (0.0–3.3)
If you were found to be HIV+, would you be willing to take free ARVs?	63.7 (40.7–89.9)	63.0 (40.7–89.9)	67.3 (42.7–83.3)
Does the availability of ARVs make you more likely to be HIV tested?	50.6 (34.0–73.3)	50.4 (34.0–73.3)	52.0 (40.7–64.0)
Do you believe that ARVs are effective in prolonging the lifespan of HIV/AIDS patients?	57.7 (32.7–90.7)	56.9 (32.7–90.7)	61.7 (34.0–78.0)
If you knew that you had to take ARVs for the rest of your life, would you be willing to take ARVs?	57.0 (33.3–83.9)	56.3 (33.3–83.9)	60.7 (41.3–70.0)
Does the availability of free drugs that prolong the lives of HIV/AIDS patients making you more likely to be HIV tested?	19.0 (1.3–42.0)	19.3 (1.3–40.0)	17.7 (3.3–42.0)

* HIV = human immunodeficient virus; AIDS = acquired immunodeficiency syndrome; VCT = voluntary HIV counseling and testing; ARVs = antiretroviral drugs. Separate summary measures for all variables were calculated for each catchment area. The range column lists the smallest and largest values calculated at all sites.

district clinic that did not correspond to the sampling frame catchment area and an additional 14% received care outside of the public health sector. The percentage selecting a different district clinic varied dramatically from clinic to clinic. At some sites, such as Chelstone and Chipata, only 1% of respondents sought care away from their designated district clinic. Other sites such as Lilayi (82%), Mandevu (78%), and Matero Main (69%) had a dramatically large percentage designate a different district clinic. These large percentages contradict our earlier assumptions about the one-to-one relationship between catchment area and clinic. Because of these inconsistencies between the expected and reported clinics of attendance, we must exercise caution in attributing clinic-level independent variables, such as time of initiated exposure to treatment services, to each household. We acknowledge that an assessment of outcomes between pre-implementation and post-implementation may have limitations. We plan on supplementing our original research plan with sensitivity analyses based on reported clinic of attendance.

We note several limitations to our methods and reported analysis. Because of the indirect method of obtaining mortality information, we acknowledge that our approach was susceptible to underrepresentation.[20,21] Survey respondents may not have disclosed all of the deaths in the household during the previous 12 months. Additionally, all household members are assumed to have resided there for the entire year and no one has moved out in the past 12 months. Previous research has shown that households often dissipate after the death of the head of household.[19] However, this potential bias appears less important when examining trends over time, as planned in this evaluation. Because each round of survey should have the same potential bias, we should be able to make valid comparisons of mortality between rounds. Because of concerns of patient confidentiality from our ethical review committees, we did not ask questions pertaining to individual HIV status. As a result, we were unable to stratify mortality according to HIV status, a notable limitation of our analysis. Finally, based on cultural norms in Zambia, we preferentially interviewed women as the head of the household. We recognize that biases may arise from this practice, particularly around perceptions and knowledge about HIV. If male surveyors were conducting the interviews, it may have also led to under-reporting of culturally sensitive perceptions and behaviors.

Thus, results from this baseline survey provide substantial knowledge about HIV and its transmission in Lusaka at a community level. However, how to access HIV care and treatment services is less well known by respondents. Mortality rates determined by this household survey approximated those of other previous studies in the country, suggesting external validity to our methods. We found that catchment area and public health facility were inconsistently related, an observation that may impact later analysis of this on-going survey. We expect that future analyses of data collected in subsequent surveys will provide important information regarding the long-term population level impact of rapidly scaling up ART services in resource-poor settings.

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