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Incidence of orphanhood before and after implementation of a HIV CARE program in Rakai, Uganda

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Abstract

Background—Scaling up of HIV care programs in sub-Saharan Africa has resulted in improved survival of HIV-infected adults, but its effect on orphanhood has not been well studied.

Objective—To compare the incidence of orphanhood among children <15 years of age before and after implementing HIV care in Rakai, Uganda.

Methods—Annual household censuses and surveys were conducted January 2001 to September 2009 in a community cohort, where HIV care including antiretroviral therapy (ART) started in June 2004. Data included parental survival of children aged –14 years, and HIV status from consenting adults aged 15–49 years. The incidence of orphanhood was estimated as the number of new orphans divided by person-years, determined during three time periods: *Pre-HIVcare* roll-out (January 2001–June 2003) 1–3 years before the advent of HIV care in Rakai program, *HIVcare-transition from* September2003–May2006, and the *Expanded HIVcare* period from August2006–September2009. Poisson regression was used to estimate incidence rate ratios (IRR) of orphanhood and 95% confidence intervals, and the Population attributable fraction (PAF) of incident orphanhood due to HIV+ parental status was estimated as pd*(RR-1)/RR.

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Competing interests
We declare that we have no competing interests

Authors' contributions
FEM: Project conceptualization, statistical analysis and interpretation and manuscript
GN: Literature review, drafting and manuscript revision
JS: Data management and manuscript revisions
IL: Data management and manuscript revisions
JK: Drafting Manuscript and interpretation of statistical results
TL: Statistical analysis and drafting Manuscript
MW: Critical review of manuscript and interpretation of statistical results
RG: Statistical interpretation, drafting and critical review of manuscript

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Results—A total of 20 823, 21 770 and 23 700 children aged 0–14 years were censused at the three *periods*, respectively. The prevalence of orphanhood significantly declined; 17.2% during *Pre-HIVcare roll-out*, 16.0% at *HIVcare-transition*, and 12.6% at *Expanded HIVcare* period (χ^2 for trend, p<0.0001). The incidence of orphanhood also declined significantly with increasing HIV care from 2.10/100py, 1.57/100py and 1.07/100py (χ^2 for trend, p<0.0001). The largest declines were observed among children with HIV+ parent(s), 8.2/100pyr, 5.2/100pys and 3.4/100pyr. PAF also declined from 35.3% in the *pre-HIVcare* to 27.6% in the *Expanded HIVcare* periods

Conclusion—After the availability of ART there was decline in population attributable fraction of incident orphanhood due to parental HIV+ status, and in the incidence of orphanhood especially among children with HIV-infected parents.

Keywords

Incidence; orphanhood; HIV care; ART; PAF; Uganda

Introduction

Sub-Saharan Africa (SSA) remains heavily affected by HIV/AIDS contributing at least two thirds of the global 33 million infected cases, and 60% of the 2.7 million global annual new infections (UNAIDS 2008). HIV/AIDS-related adult mortality has resulted in a large number of orphaned children (Sewankambo NK et al., 1994, 2000;Makumbi FE et al., 2005). In Uganda 23.3% of children aged 0–14 years have lost one or both parents, and 30% are either orphans or vulnerable children (UDHS 2006). Studies conducted in Zimbabwe, Uganda, and Tanzania, Malawi and South-Africa indicate a high incidence of orphanhood ranging from 1.5–2.7 per 100 person years (py) (Hosegood V et al 2007; Watts H et al 2005; Makumbi F et al 2005), with about 37.3% risk of incident orphanhood attributable to parental HIV-infection (Makumbi F et al, 2005). However, since the advent of HIV care services such as cotrimoxazole prophylaxis and antiretroviral therapy (ART), there is increased survival among HIV-infected adults and a reduction in orphanhood incidence among children under-18 years with HIV-infected parents (Mermin J et al, 2004; Mermin J et al, 2008;Nunn A et al, 2008;UNAIDS 2008). A study conducted in Tororo Uganda showed that provision of ART in a cohort of HIV-infected adults was associated with a 93% reduction in orphanhood, and a reduction in mortality among both uninfected children and their infected parents (Mermin et al 2004; 2008). In Botswana, model based estimates also suggest reductions in the number of new orphans by 40% as result of ART programs which covers about 80% of those in need (Stover J et al, 2008), and a preventive impact on children welfare and health if HAART access is universal (Anema A et al., 2011). Although the scale up of HIV care programs in SSA has resulted in improved adult survival of the HIV infected individuals, the effect of these programs on the incidence of orphanhood has not been fully explored at a population level. We therefore compared the incidence of orphanhood among children aged <15 years of age before and after the implementation of an HIV care program in a rural resource limited setting of Rakai district, southwestern Uganda with a mature generalized HIV/AIDS epidemic.

Methods

Study setting and population

The Rakai Health Sciences Program (RHSP) is a collaboration between researchers working at the Johns Hopkins University, Baltimore, USA, and Makerere University, Kampala Uganda and the Ministry of Health through the Uganda Virus Research Institute, Uganda. RHSP has followed a population-based cohort in 50 rural villages in Rakai district since 1994 through the Rakai Community Cohort Study (RCCS), with annual follow-up of all persons aged 15–49 years. The community cohort annually collects census data including marital status, sex, age of each resident and each individual household member's relationship to the household head, their survival status, and out- or in-migration into the household. During census data collection, questions about survival of biological parents for each household member are asked to determine if one or both parents are alive or dead, and if still alive then co-residence is determined. Data on household possessions (radio, TV, automobile, bicycle, and latrine), structure (type of roofing material, floor, walls and number of rooms), type of water sources (collected after 1998), and possession of domestic animals and poultry are also obtained. Study participants are recruited through household surveys, where individual interviews are conducted with consenting participants, using a quantitative data collection tool, and blood for HIV testing is obtained. Annually a total of about 14000 participants aged 15–49 years are interviewed through same sex interviewer-administered questionnaires. For this analysis, the HIV care period was categorized into three intervals, *Pre-HIVcare roll-out* (January 2001–July 2003) 1–3 years before the advent of HIV care in the Rakai program, *HIVcare-transition from* September2003–June2006 which includes the year of initiation of the HIV care program; and the *Expanded HIVcare* period from August2006–November2009, which is 2–5 years after the HIV care program was established. The proportion of adult (15–49 years) HIV positive study participants receiving ART in Rakai at the two HIVcare periods when HAART was available in the communities; in the *HIVcare-transition* (~10% females, 7% males), and in the *Expanded HIVcare* (~20% female, 18% males). However, during the *Expanded HIVcare* period, about 48% females, and 37% males who were HIV+ were enrolled into HIV care including pre-ART services. Each adult with available HIV results was linked to their HIV-test results at the start of each of the three *HIV care* inter-survey analysis periods. Then every child with a co-resident biological parent was linked to the parent's HIV status. Parental HIV status was categorized as HIV-negative (*HIV-negative*) if both parents were HIV-uninfected, or one parent uninfected and the other with unknown status; HIV-Positive (*HIV+*) if at least one parent was known to be HIV-infected; Unknown status if both parents' HIV status was unknown at the start of each inter-survey *HIVcare* period The children's age was categorized as <5 years (0–4), 5–9 years or 10–14 years.

All consenting participants provided venous blood for HIV-1 testing using two different enzyme immunoassay (Vironostika HIV-1, Organon Teknika, Charlotte, North Carolina, USA, and Cambridge Biotech, Worcester, Massachusetts, USA), with Western blot confirmation of all discordant tests and of all HIV seroconverters (HIV-1 WB Bio-Merieux–Vitek, St Louis, Missouri, USA).

Household social economic status (SES) was based on the structure of the dwelling. Modern construction materials such as cement, iron sheets or roofing tiles are expensive and their use in this rural setting is a potential indicator of wealth. Therefore, the dwelling structure was categorized as High SES if its roofing material was iron/tiles, and both the walls and floor were cement, while as Low SES if dwelling structure had only one or none of the modern materials (for the roof, walls and floor) used in construction of the High SES. The Middle SES category had at most two of the dwelling structure parts (roof, walls and floor) constructed using modern materials. Materials most commonly used by Low SES households were grass thatch for the roof, and mud and wattle for the walls or floor. All annual census and survey data were collected by well trained and experienced research assistants (RA) who visit all households in the communities at every study round. The RCCS where these data are drawn received ethical clearance from the Uganda Virus Research Institute Science and ethics Committee, and the Uganda national council of Science and Technology

HIV Care Program

Since June 2004, with funding from the President's Emergency Plan For AIDS Relief (PEPFAR), the Rakai Health Sciences Program (RHSP) has cumulatively provided HIV care to about 5000 individuals, including ART to approximately 2300 HIV-infected persons, with a CD4≤250 cells/mm^3 or WHO Stage IV disease. HIV care was provided via 17 mobile community-based out-patient clinics, called Suubi or "Hope" clinics, operated on a bi-weekly basis. All patients received a health status evaluation, health and HIV prevention education, treatment for opportunistic infections, and a basic HIV care package consisting of cotrimoxazole for opportunistic infection prophylaxis, a clean water vessel and hypochlorite solution for water disinfection, two insecticide treated bed nets for malaria prevention, and were offered free condoms. Among the Rakai cohort participants interviewed between February 2005–August 2006, 11.9% (1451/12216) were HIV+. However, only 68.5% (784/1145) of the HIV+ individuals enrolled into HIVcare within six months post receipt of VCT; enrolment into HIVcare was greater among females-71% relative to males (62.3%) (Nakigozi G et al, 2011).

Statistical analysis

The prevalence of orphanhood was estimated as the proportion of children aged less than 15 years, with one or both parents deceased identified at household censuses at the baseline survey of each of the HIV care analysis period, i.e. January 2001/April2002 (*pre-HIVcare roll-out*), September2003/October2004 (*HIVcare-transition*), and *Aug 2006/March 2008* (*Expanded HIVcare*) periods. The proportion of adult (15–49 years) HIV positive study participants receiving ART in Rakai at the two HIVcare periods when HAART was available in the communities; in the *HIVcare-transition* (~10% females, 7% males), and in the *Expanded HIVcare* (~20% female, 18% males). However, during the *Expanded HIVcare* period, about 48% females, and 37% males who were HIV+ were enrolled into HIV care including pre-ART services. All orphans were children aged < 15 years and resident in the household at the baseline survey of each HIV care period; a maternal orphan was defined as a child with a dead biological mother but with a biological father still alive irrespective of his co-residence status; a paternal orphan was a child with a dead biological father but with a biological mother still alive irrespective of her co-residence status, while a double orphan was a children who had both biological parents dead. For all children with any of the surviving biological parent, we assessed parental co-residence by orphanhood status and type.

For the incidence of orphanhood, children who were non-orphans at the baseline survey of each of the HIV care analysis period , and were still residents in those households at the inter-survey follow-up visit were included in this analysis. The incidence was estimated as the number of children who lost at least one parent during the inter-survey HIV care follow-up periods, divided by the total person-years of exposure for non-orphaned children eligible for the incidence analysis at each HIV care period baseline survey. It was assumed that on average, incident orphanhood occurred in the mid-point of each follow-up interval (*because dates of parent's death were not known*), on the assumption that these events were evenly distributed over time. Children in household who out-migrated between each HIV care period baseline and follow-up censuses were removed from the analysis within that interval. Children's age was collected as of last birthday because many of the adult respondents could not tell the exact dates of birth. Thus for this analysis, eligibility was being less than 15 years at the start of each HIV care interval, whose median was 1.3 person-years. We estimated the incidence of orphanhood per 100 person years (py) as the number of new orphans divided by person-time of follow-up, overall and stratified by the child's reported ages categorized as 0–4, 5–9 and 10–14 years and parental HIV status. We used Poisson regression to estimate the incidence rate ratios (IRR) of orphanhood and their 95% confidence intervals comparing the three HIV care periods; pre-*HIVcare roll-out, HIVcare-transition and Expanded HIVcare* period.

We estimated the population attribution fraction (PAF (%)) of incident orphanhood due to HIV+ parental status using the formula, PAF = pd*((IRR-1)/IRR); where pd=proportion of cases (incident orphans) exposed to the risk factor (HIV+ parent); IRR=the incidence rate ratio (the relative risk) adjusted for potential confounders (Rockhill B et al 1998). We also conducted a test for trend for the prevalence and incidence of orphanhood. Statistical analyses used Stata software package version 9.2 (*College Station, Texas, USA*).

Sub-analysis for the competing risk—In order to address the competing risk of child death and becoming orphaned, we conducted a competing risk analysis in a sub-analysis. In this analysis, we constructed a composite orphanhood/mortality outcome measure, which combined both the incidence orphanhood and death of children aged 15 years or less, during the inter-survey visits considered for this analysis.

Results

Table 1 shows the distribution of children and household characteristics. We observed a higher proportion of females and the under-five (U5) children across all HIV care periods. About 9% of the children had at least one parent known to be HIV+. Majority (~ 57%) of the children are still co-resident with their biological parents. Children's co-residence was higher with the mother compared to the father, irrespective of whether the child was an orphan or a non-orphan, across all HIV care periods. The proportion of children in households with a “high” dwelling structure ranking, as a measure of social economic status(SES) has been significantly increasing over the HIV care periods, 31.9%, 35.4% to 41% (χ^2 for trend = 192.75, p<0.0001).

Table 2 shows the prevalence of orphanhood by the children’s age and parental HIV-infection status at *the three time periods*. A total of 20 823, 21 700 and 23 700 children aged 0–14 years were available in the censused households at the baseline visit of each HIV care periods, making them eligible for this analysis. On average, 9.0% of the eligible children had at least one known HIV+ parent at the baseline survey of each HIV care period. Overall, the prevalence of orphanhood was highest in the earliest *Pre-HIVcare* roll-out period 17.2% which declined to 16.0% at *HIVcare-transition*, and 12.6% at Expanded *HIVcare* (χ^2 for trend, p<0.001). Paternal orphanhood was the most prevalent form of parental loss in all age groups and time periods. Loss of both parents (double orphanhood) was higher than loss of a mother-alone during the first two periods, but very similar during the Expanded HIVcare period (2006–2009). The prevalence of orphanhood declined markedly between the *pre-HIVcare roll-out* and *HIVcare periods* among children born to HIV+ parents and those with unknown parental HIV status. The prevalence of orphanhood was significantly lower among children in Middle SES households relative to those in High/low SES, irrespective of the HIVcare period.

The incidence of orphanhood by child’s age, and parental HIV status is shown in Table 3. A total of 13 689, 14 258 and 15 472 were non-orphans at the baseline visit of each of the three time periods, respectively, and were still available in their households at the follow-up visit making them eligible for this analysis. The median (IQR) follow-up time in years in the inter-survey periods were 1.23 (1.19, 1.26) for *Pre-HIVcare roll-out, 1.43 (1.40, 1.45)* for *HIVcare-transition* and 1.72 (1.69, 1.77) for *HIVcare* periods. A total of 943 incident orphans were observed with 346 in pre-HIVcare roll-out, 314 in *HIVcare-transition* and 281 in the Expanded *HIVcare* period. In all the three periods, paternal orphanhood contributed the highest proportion of new orphans; 66.5%, 74.7% and 73.0% in the three consecutive periods, respectively. Comparing the *pre-HIVcare* and *HIVcare* periods, among the incident orphans, the proportion of paternal orphans significantly increased 66.5% to 73.0%.

The incidence of orphanhood declined significantly from 2.10/100 py during the *pre-HIVcare roll-out* to 1.57/100py at *HIVcare-transition*, and to 1.07/100 py during the Expanded *HIVcare period* (p <0.001). Although there was a general decline in the incidence of orphanhood even among children of HIV-uninfected parents, the largest declines in incident orphanhood were more evident among children with HIV+ parent(s), 8.1/100pyr in the *pre-HIVcare roll-out*, 5.2/100pys in the *HIVcare-transition* and 3.4/100pyr in the Expanded HIVcare period. Among children aged 0–4 years with HIV infected parents, the incidence of orphanhood prior to HIVcare roll-out was high at 7.71/100 py, but significantly declined during HIVcare-transition (3.52/100 py) and Expanded *HIVcare* periods (2.22/100py). Similar trends were observed for the 5–9 and 10–14 year olds.

Table 4 shows the PAF of incident orphanhood due to parental HIV status by HIV care periods. The population attributable fraction of incident orphanhood declined from 35.3% in the pre-HIVcare to 27.6% in the Expanded HIVcare-initiation periods. Although the incidence of orphanhood significantly declined between the pre-HIVcare roll-out and the HIVcare-Transition periods, irrespective of parental HIV status, the proportion of incident orphans with an HIV+ and PAF was similar across the periods.

In the sub-analysis for the competing risk analysis, there was a significant decline in the composite outcome over the three HIVcare periods. The overall incidence in the composite orphanhood/mortality outcome was 3.1/100py (517/16636.24) in pre-HIVcare periods; 2.5/100py (507/20356.96) in *HIVcare-transition*; and 1.5/100py (405/26430.96) in Expanded HIVcare period (χ^2 for trend p<0.0001). The greatest declines in composite orphanhood/mortality outcome were observed among children with HIV+ parents, 10.3/100py (129/1256.7); 7.5/100pys (112/1498.8) and; 4.6/100pys (92/1993.4) (χ^2 for trend p=0.001), in the three increasing HIVcare time periods, respectively. The declining trends are similar to what we observed when incidence of orphanhood was the only event of interest.

Discussion

The scale up of HIV care programs has resulted into significant reductions in the rates of prevalent and incident orphanhood among children born to HIV-infected parents. The incidence of orphanhood among children of HIV-infected parents prior to availability of HIVcare was high but declined substantially during the HIV care transition and Expanded HIVcare implementation periods. These findings are consistent with model estimates from Botswana that indicated a 40% decline in new orphanhood rates when ART uptake was 80% for those in need (Stover et al 2008) , and a study in Tororo Uganda that showed a 93% reduction in orphanhood among children of HIV+ patients started on ARVs (Stover et al 2008; Mermin et al, 2008).

In this study, we have also provided information on the increasing uptake if HIV care services in this cohort. A previous study in the same cohort showed that 68.5% of HIV+ patients who received VCT and were in need of care were able to enroll into a community HIV care program offered by the Rakai health Sciences Program (Nakigozi G et al, 2011). Unpublished observations in this cohort indicate an increase in the proportion of all HIV+s receiving ART among females from 10% to 20%, and among males from 7% to 18% during the *HIVcare transition and Expanded HIV care* periods, respectively. Therefore, the observed declines in incident orphanhood may be linked to the increasing coverage of HIV care including receipt of ART in this population.

The observed declines in incident orphanhood can be attributed to the improvement in survival of HIV-infected adults as shown in previous studies elsewhere (Mermin et al 2008; Abraham J Herbst et al, 2009; Reniers G et al, 2009; Jahn A et al, 2008). About 37 % of incident orphanhood in this cohort has previously been shown to be attributable to parental HIV infection (Makumbi et al 2005), and that most adult deaths in Rakai (Sewankambo et al, 1994; 2000) or in other SSA settings were attributable to HIV infection (Mulder DW et al., 1994; Todd J et al., 1997; Boerma JT, 1998). This current analysis also showed a decline in the population attributable fraction of incident orphanhood due to parental HIV+ status, further suggesting that the availability of HIV care is improving the survival of HIV-infected adults thus reducing incident orphanhood.

We also observed a significant decline in the rate of orphanhood among children with HIV uninfected parents. This observed incidence of orphanhood among children with uninfected parents was similar to a study conducted in Zimbabwe (Watts H et al, 2005). Also, this finding is consistent with global trends of declining adult non-HIV mortality (Rajanaratram et al, 2010), probably due to general improvement in health services. However, our estimated incidence of orphanhood among children with uninfected parents could be an overestimate of the actual incidence because children with HIV-discordant parents may have been included in the HIV-uninfected category. All children with only one known HIV-negative parent and the other with unknown status were categorized as HIV-negative.

In this study, we addressed the competing risks of incident orphanhood and, infant and child mortality. Availability of HAART may have improved child survival or resulted in more HIV-uninfected children whose parents were HIV+, and at the same time increasing adult survival thus reducing incident orhanhood. However, the similar declining trends were observed when incident orphanhood alone and composite orphanhood/mortality outcome were analyzed. This result further showed that HAART and HIV care are impacting on incident orphanhood.

This observed decline in the rate of orphanhood associated with provision HIVcare will result in fewer children in need of caregivers, thus lowering the overall risk of poor health among these children. (Sarkar NR et al., 2003;Bishai et al, 2003). Previous studies have showed that orphans were at increased risk of severe malnutrition (Nyandiko WM et al, 2009), School dropout or face social consequences of orphanhood such as teenage pregnancies, (Palermo T et al, 2009), sexually transmitted infections (Birdthistle IJ et al, 2008; Gregson S et al, 2005), poor mental health (Mónica et al, 2009), and deficits in height (Kathleen Beegle et al, 2009).

Therefore, our study strongly suggests that the HIV care programs in sub-Saharan Africa should continue to roll out because of the already known benefits of HIV care to the individuals infected including improved survival and better health, and the resulting decline in the incidence of orphanhood, as evidenced from this analysis.

Limitation and strengthens

Overall, about 35% of the observations had missing data on parental HIV status, which may lead to an under estimate of the contribution of the parental HIV status to incidence orphanhood. Indeed the out-migration of HIV/AIDS parents who seek care elsewhere, may lead to underestimate of HIV+ associated incidence orhphanhood.

Declining infant and child mortality as a result of improving ART provision especially among the children of HIV/AIDs infected parents, may lead to competing risk for the orphanhood event, thus leading to underestimation. However, we have conducted competing risk analysis to account for this potential competing risk. The trends are similar to when no competing risk assessment are taken into account.

These are the first empirical data on the impact of HAART on the incidence of orphanhood. Most of the previous findings have been based on models. Therefore, these findings will contribute to the much needed inputs for those using modeling approaches to the benefits of HIV care on incident orphanhood.

Conclusion

There was a significant decline in the prevalence and incidence of orphanhood especially among children with HIV-infected parents, and a decline in PAF of incident orphanhood due to parental HIV+ status, after the availability of HIV care programs. These findings suggest that the anticipated numbers of orphaned children due to HIV/AIDS and the consequences of orphanhood may be substantially reduced, especially if a high access to ART is achieved.

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Table 1

Distribution of children and household characteristics by HIV care period

	Pre-HIVcare roll-out *Jan 2001/April 2002*)		HIVcare-Transition (*Sept 2003/Oct 2004*)		Expanded HIVcare (*Aug2006/March 2008*)	
	N	**%**	**N**	**%**	**N**	**%**
Total	20,823	100	21,770	100	23,700	100
Gender						
Female	10,633	51.1	11,145	51.2	12,211	51.5
Male	10,190	48.9	10,625	48.8	11,489	48.5
Age-group						
–4	8,090	38.9	8,115	37.3	8,686	36.6
5–9	6,773	32.5	7,225	33.2	7,869	33.2
1–14	5,960	28.6	6,430	29.5	7,145	30.1
Parental HIV status						
Both HIV-/One known HIV- and one Unknown	11,303	54.3	11,389	52.3	13,765	58.1
Both unknown	7,639	36.7	8,535	39.2	7,888	33.3
At least one known HIV+	1,881	9.0	1,846	8.5	2,047	8.6
Parental co-residence						
Non-orphans						
Both-co-resident	11,949	57.4	12,332	56.6	13,634	57.5
Both-not co-resident	2,192	10.5	2,486	11.4	3,001	12.7
Mother not co-resident	776	3.7	895	4.1	1,009	4.3
Father not co-resident	2,323	11.2	2,567	11.8	3,071	13.0
Orphans						
Paternal but mother not co-resident	692	3.3	635	2.9	567	2.4
Maternal but father not co-resident	405	1.9	424	1.9	396	1.7
Paternal, with co-resident mother	1,214	5.8	1,184	5.4	1,046	4.4
Maternal, with co-resident father	351	1.7	321	1.5	280	1.2
Double orphans	921	4.4	926	4.3	696	2.9
Household's SES Dwelling structure Ranking**						
High	6,636	31.9	7,714	35.4	9,802	41.4

	Pre-HIVcare roll-out *Jan 2001/April 2002)*		HIVcare-Transition *(Sept 2003/Oct 2004)*		Expanded HIVcare *(Aug2006/March 2008)*	
	N	**%**	**N**	**%**	**N**	**%**
Middle	5,622	27.0	6,428	29.5	7,366	31.1
Low	8,556	41.1	7,622	35.0	6,511	27.5
Toilet/latrine						
None	928	4.5	463	2.1	701	3.0
Yes	19,895	95.5	21,306	97.9	22,971	97.0
Source of water						
Lake/river	559	2.7	2,038	9.4	1,819	7.7
Tap/protected	20,264	97.3	19,732	90.6	21,874	92.3

Table 2

Trends in the prevalence of orphanhood by child age, parental HIV status and HIV-care period

	Pre-HIVcare roll-out (*Jan 2001/ April 2002*)		**HIVcare-Transition (*Sept 2003/ Oct 2004*)**		**Expanded HIVcare (*Aug2006/ March 2008*)**		**p-value for χ^2 test for Trend over time**
All	**N**	**(%)**	**N**	**(%)**	**N**	**(%)**	
Type of orphanhood	**20,823**	**(100)**	**21,770**	**(100)**	**23,700**	**(100)**	
Overall orphans	3,583	(17.2)	*3490*	*(16.0)*	*2985*	*(12.6)*	*<0.001*
Double	921	(4.4)	926	(4.3)	696	(2.9)	
Maternal-alone	756	(3.6)	745	(3.4)	676	(2.8)	
Paternal-alone	1,906	(9.2)	1,819	(8.4)	1,613	(6.8)	
***Parental HIV status**							
HIV+	463/1881	(24.6)	439/1846	(23.7)	377/2047	(18.4)	<0.0001
HIV-negative	641/11303	(5.7)	587/11389	(5.2)	638/13,765	(4.6)	0.0002
Unknown	2479/7639	(32.5)	2464/8535	(28.9)	1969/7888	(25.0)	<0.0001
Children with HIV+ parents							
–4 HIV+	68/790	(8.6)	61/729	(8.4)	33/767	(4.3)	0.001
5–9 HIV+	187/633	(29.5)	148/634	(23.3)	123/681	(18.1)	<0.0001
1–14 HIV+	208/458	(45.4)	230/483	(47.6)	221/599	(36.8)	<0.0001
Children with unknown parent HIV status							
–4	168/1809	(9.3)	169/2192	(7.7)	139/2018	(6.9)	0.0063
5–9	793/2717	(29.2)	739/2864	(25.8)	585/2676	(21.7)	<0.0001
1–14	1518/3113	(48.8)	1556/3479	(44.7)	1245/3194	(39.0)	<0.0001
Household's SES Rank of dwelling structure**							
High	150/1464	(10.2)	138/1689	(8.2)	194/2529	(7.7)	
Middle	38/446	(8.5)	18/354	(8.1)	33/873	(3.8)	
Low	3395/18913	(18.0)	3334/19726	(17.0)	2758/20292	(13.6)	

Orphanhood prevalence was calculated based on reported loss of one or both parents at start of each analysis interval(period)

* HIV-negative: Both parents are HIV- or one is HIV-negative and the other has unknown status; HIV+: At least one parent HIV+; Unknown: Both parents' status unknown

** High if iron/tiles (roof), cement (walls and floor); LOW if no modern materials but mainly grass thatch roof and, mud and wattle for walls and/or floor; Middle SES if at most two parts of structure used modern materials; about 7 observation are missing data on SES

Table 3

Incidence of orphanhood by child's age parental HIV status by HIVcare periods

	Pre-HIVcare roll-out **(January 2001–July 2003))**			**HIVcare-*Transition*** **(September2003–June2006)**			**Expanded HIVcare** ***(Aug 2006–Sept 2009)***		
	Total non-orphans	**Incident orphan/py**	**Incidence rate/100py**	**Total non-orphans**	**Incident orphan/py**	**Incidence rate/100py**	**Total non-orphans**	**Incident orphan/py**	**Incidence rate/100py**
Overall	**13,689**	**346/16483.9**	**2.10**	**14,258**	**316/20222.2**	**1.56**	**15,472**	**281/26299.3**	**1.07**
Parental HIV status									
HIV-negative	8,833	140/10702.3	1.3	9,082	102/12942	0.8	10,538	123/18004	0.7
Unknown	3,790	105/4543.4	2.3	4,117	138/5808.7	2.4	3,750	92/6328.9	1.5
HIV+	1066	101/1238.3	8.2	1059	76/1471.6	5.2	1184	66/1966.2	3.4
Child Age (years)									
–4	6,198	101/7511.2	1.34	6,260	85/8909.0	0.95	6,475	83/11038.5	0.75
Parental HIV status									
HIV-negative	4,457	29/5433.0	0.53	4,357	36/6213	0.58	4,780	47/8181.3	0.57
Unknown	1,207	24/1455.7	1.65	1,417	25/2012.2	1.24	1,184	17/2001.6	0.85
HIV+	534	48/622.3	7.71	486	24/682.7	3.52	511	19/855.5	2.22
5–9	4,738	137/5688	2.41	5,199	137/7362	1.86	5,734	123/9736	1.26
Parental HIV status									
HIV-negative	2,825	61/3408.2	1.79	3,191	37/4549.2	0.81	3,793	53/6472.8	0.82
Unknown	1,547	40/1856.1	2.15	1,605	67/2255.7	2.97	1,499	43/2529.8	1.70
HIV+	366	36/424.0	8.49	403	33/556.7	5.93	442	27/732.8	3.68
1–14	2,753	108/3284	3.29	2,799	94/3951	2.38	3,263	75/5525	1.36
Parental HIV status									
HIV-negative	1,551	50/1861.0	2.69	1,534	29/2178.7	1.33	1,965	23/3350.0	0.69
Unknown	1,036	41/1231.3	3.33	1,095	46/1540.6	2.99	1,067	32/1797.4	1.78
HIV+	166	17/191.9	8.86	170	19/231.9	8.19	231	20/377.8	5.29

[*] HIV-negative: Both HIV- or HIV- and other unknown; HIV+: At least one parent HIV+; Unknown: Both parents' status unknown

Table 4

Population Attributable Fraction of incidence of orphanhood due to parental HIV by HIVcare periods

	Pre-HIVcare roll-out (January 2001–July 2003)		**HIVcare-Transition (September2003–June2006)**		**HIVcare (*Aug2006/November 2009*)**	
	Parental HIV status					
	HIV-	**HIV+**	**HIV-**	**HIV+**	**HIV-**	**HIV+**
Total non-orphans	8,833	1,066	9,082	1,059	10,538	1,184
Person-years	10702.3	1238.3	12942.0	1471.6	18004.3	1966.2
Incident orphans	140	101	102	76	123	66
Incidence/100py	1.3	8.2	0.8	5.2	0.7	3.4
*Adjust IRR (95%CI)	1.0	6.25 (4.82, 8.11)	1.0	6.65 (4.94,8.96)	1.0	4.73 (3.94,6.40)
Proportion of incident orphans with HIV+ parent	0.42		0.43		0.35	
PAF (%) = pd*((IRR-1)/IRR)	35.3		36.5		27.6	

*adjusted for child age, household SES as measured by dwelling structure ranking and source of water