

**WORKSHOP ON HIV/AIDS AND ADULT MORTALITY
IN DEVELOPING COUNTRIES**

Population Division
Department of Economic and Social Affairs
United Nations Secretariat
New York, 8-13 September 2003

ORPHANS AND AIDS IN SUB-SAHARAN AFRICA *

Nicholas C. Grassly ** and Ian M. Timaeus ***

* This document was reproduced without formal editing.

** Department of Infectious Disease Epidemiology, Imperial College Faculty of Medicine, London, United Kingdom.

***Centre for Population Studies, London School of Hygiene & Tropical Medicine, London, United Kingdom. The views expressed in the paper do not imply the expression of any opinion on the part of the United Nations Secretariat.

SUMMARY

Demographic projections based on HIV prevalence data suggest that at the end of 2002 an estimated 15 million children living in sub-Saharan Africa aged under 15 years old had lost their mother and/or father to AIDS. The African orphan crisis is revealed not only by demographic projections, but also by household surveys that ask questions about parental survival. In countries with severe HIV epidemics Demographic and Health Surveys have recorded an increase over the last decade in the fraction of children whose parents have died, and there is a significant correlation between orphanhood and adult HIV prevalence ($p = 0.03$).

Surveys and projections also reveal some of the characteristics of orphans that are relevant to policy. Both show on average twice as many children have a dead father than mother; both show an increasing prevalence of orphanhood with age, such that 10-14 year old children make up half of all orphans under the age of 15 years; and in countries with severe HIV epidemics, both show a significant rise in the fraction of orphans whose mother and father have died, due to the sexual transmission of HIV.

Projections can additionally be used to look more directly at the characteristics of AIDS orphans, evaluate orphanhood at ages older than 14 years and explore the impact of HIV/AIDS on child welfare other than through parental death. Including children aged 15-17 years old would increase estimates of the total number of orphans in sub-Saharan Africa at the end of 2002 from 35 to 47 million. Including 'vulnerable' children whose mother or father has AIDS would add 10% to the numbers of maternal and paternal AIDS orphans respectively. Vulnerability, however, is a nebulous concept and different aspects of a child's welfare may be put at risk by HIV/AIDS through a variety of mechanisms. To gain a better understanding of the impact of orphanhood on child welfare in different settings, in depth longitudinal studies of the orphaning process, from parental illness and death to the child's survival to adulthood (or death) are needed.

A. INTRODUCTION

By the end of 2002 the HIV pandemic had directly resulted in the deaths of over 25 million people, leaving behind close to 15 million children under the age of 15 without their mother or father (UNAIDS and others, 2002; UNAIDS/WHO, 2002). Over 80% of these orphans are living in sub-Saharan Africa, where for the last two decades communities and the extended family have been struggling to cope with the increasing burden of care. It is only recently that the international community has begun to recognise and commit resources to the problem of care for children orphaned by AIDS (Foster, 2002). In 2001 the United Nations General Assembly adopted a 'Declaration of Commitment' on HIV/AIDS that included a pledge to "care for all whose lives have been devastated by AIDS, particularly the more than 13 million orphans." This paper attempts to describe the characteristics of orphans in Africa and how these characteristics are changing due to the HIV epidemic.

The word orphan is derived from the Greek *orphanos*, meaning without parents. Although in its colloquial usage orphan typically refers to a child whose parents have both died, most dictionaries allow for the inclusion of children whose mother or father only have died. Thus the Oxford English Dictionary defines an orphan as 'a child whose parents have died; a fatherless or motherless child' (Brown, 1993). It is this, more inclusive definition that has been adopted by the international community. Maternal orphans are defined as those children whose mother has died irrespective of the survival status of the father. The definition of paternal orphans follows the same logic. Double or dual orphans are those children whose parents have both died.

In the past, most statistics on orphans due to AIDS concerned only maternal orphans. More recently, methods to estimate paternal and double orphans due to AIDS and other causes have been described

(Grassly and Timaeus, submit.) and estimates based on these methods published by the United Nations (UNAIDS and others, 2002). These estimates use the definition of an AIDS orphan as ‘a child who has at least one parent dead from AIDS’ and a double (or dual) AIDS orphan as ‘a child whose mother and father have both died, at least one due to AIDS’ (UNAIDS Reference Group on Estimates Modelling and Projections, 2002). Statistics on orphans due to AIDS and other causes are typically presented for children under the age of 15 years (UNAIDS and others, 2002). However, people are usually considered children up to and including age 17 years, in keeping with the Convention on the Rights of the Child. Including 15 to 17 year old children can significantly increase estimates of orphan numbers.

Orphans are not the only children adversely affected by the HIV pandemic. Children whose parents have HIV-related sickness or whose wider family are ill or dead due to HIV/AIDS will also suffer. Additionally, HIV has the capacity to compromise health, education and other services, thus further undermining child welfare. It is much harder to reach consensus on the definition of such children (Foster and Williamson, 2000; Monk, 2002), though perhaps this is unnecessary, so long as there is some attempt to quantify this indirect effect of HIV on child welfare. Indeed, the definition of a vulnerable child is more often determined by data availability than conceptual issues (UNICEF and UNAIDS, 2003).

An effective policy response to the orphan crisis requires some information about the characteristics of those being orphaned. These might include their age distribution, parental status, location and the socioeconomic situation of those households that foster orphans. In this paper we focus on the two former characteristics (we direct the reader to a recent analysis of Demographic and Health Surveys (DHS) for the latter (Bicego and others, 2003)). We use both empirical data from household surveys and projections based on mortality statistics from UNAIDS/WHO, and make comparisons of these data. We additionally explore the impact on current orphan statistics of including 15 to 17 year old children and the numbers of children made ‘vulnerable’ by HIV/AIDS according to various criteria.

B. DATA AND METHODS

1. Demographic and Health Surveys

DHS are large, nationally representative household surveys that have been carried out since 1984 in over 60 less developed countries with the support of the United States Agency for International Development. Since 1990 most African surveys have asked about the survival status of the parents of all children living in the household at the time of the survey. The questions asked are “Is NAME’s mother still alive?” and “Is NAME’s father still alive?” In this paper we compile orphan data based on this question for 37 DHS carried out in 26 sub-Saharan African countries, each of which collected information on between 8,000 and 31,000 children (Table 1).

These data cover countries from all parts of the region and include eight recent surveys from countries with severe HIV epidemics. Data from the 1999 survey in Nigeria and 1993 survey in Ghana were excluded from the analysis. The former had a 6.5% non-response rate for questions about survival of parents and internal consistency checks suggest a disproportionate fraction of non-responders had dead fathers. The latter had an implausibly high proportion of children whose parents had both died that the 1998 survey failed to confirm.

Care must be taken in interpreting household survey data on orphan prevalence since response to questions about parental survival may be biased in several ways. Some orphans may simply be living outside households in institutions or on the street. However, in most of Africa the numbers of such children is likely to be small at present and restricted to urban areas (Bicego and others, 2003). Additionally, a small number of orphans may not be classified as household ‘residents’ due to residential transition or employment as a live-in domestic servant. Children orphaned at a young age may sometimes be misreported as non-orphans in surveys, since foster carers may be reported as a child’s natural parents

(Timæus, 1998). This may be more common for maternal than paternal orphans, since men are more likely to re-marry and the step-mother may then be reported as the child's biological mother (Bicego and others, 2003). Surveys may also fail to correctly determine the survival status of parents who do not reside with the child. This may lead to overestimation of orphans if social desirability means that long absent parents are reported as dead. Alternatively, it may lead to underestimation where news of the death of an absent parent has not yet reached the household. The size of these biases is unclear. However, the proportions of children with absent parents in a survey is not correlated with levels of reporting of dead parents, suggesting it is not large (Grassly and Timæus, submit.).

2. Projections of orphan numbers

To estimate orphan numbers from projections of adult mortality due to AIDS and other causes we use methods described elsewhere (Grassly and Timæus, submit.; UNAIDS and others, 2002). These methods estimate the number of children born to those who have died using age-specific female and male fertility estimates. The probability these children survive to be counted as orphans is then calculated from child survival schedules. In the presence of HIV these calculations are complicated by the impact of HIV on fertility and child survival, and difficulties in estimating the HIV status of the children of men who died from AIDS.

To estimate orphans aged up to 17 years old we use the same procedure reported in Grassly and Timæus (submit.), with the caveat that the coefficients used to estimate double orphans aged 15-17 must be based on the coefficients for younger ages, since DHS data are not available for children aged 15 or older.

We use the demographic projections from UNAIDS and the World Health Organisation that underlie the estimates of orphan numbers published in *Children on the Brink* (UNAIDS and others, 2002). However, we adjust down projections of adult deaths due to causes other than AIDS to reflect a more appropriate life table for an African population (Grassly and others, submit). In this case the ratio of adult to child mortality is lower than that predicted by the Coale-Demeny 'North' or 'West' model life tables used by the United Nations (Coale and Demeny, 1983).

C. RESULTS

1. Demographic and Health Surveys

The prevalence of orphanhood among 0-14 year old children is greater than 10% in the most recent survey in 8 of the 26 sub-Saharan African countries (Table 1). Of these, 6 countries have an estimated HIV prevalence greater than 10% at the end of 2001. The prevalence of HIV is significantly correlated with the fraction of children who are orphans for the 22 countries where prevalence and survey data are available (Spearman rank correlation $p = 0.031$). Although not a direct test of causality, this suggests HIV is having a significant and measurable impact on numbers of orphans in Africa. Countries that have recently experienced wars or conflicts, such as Mozambique and Rwanda, also have a large proportion of children orphaned.

The fraction of children who are orphans rapidly increases with age (Table 1). In most sub-Saharan African countries orphans aged 10-14 account for half of all orphans under the age of 15. The increased prevalence of orphans with age is seen for maternal, paternal and double orphans (Figure 1).

On average, twice as many children have dead fathers as have dead mothers (Rate Ratio, RR 2.0, Interquartile range, IQR 1.7-2.3). This difference is exaggerated among young children aged 0-2 years, where four times as many have lost their father than mother (RR 3.8, IQR 2.9-4.7). This reflects the higher rate of mortality for young adult men compared with women. However, because AIDS has changed the usual patterns of adult mortality seen for sub-Saharan Africa, not all countries display this

pattern. Notably, in Zimbabwe and South Africa, although more children are paternal than maternal orphans, the ratio is no greater at younger ages.

Although more fathers die than mothers, the fraction of children in a survey with dead mothers is closely correlated with the fraction with dead fathers (Figure IIa). Countries reporting more children with dead mothers or fathers also report more children whose parents have both died. However, there are more such double orphans than expected if parents' deaths were independent (Figure IIb). This is because parents may be exposed to the same risks and may also transmit diseases to one another and, in particular, HIV. The extent of the risk of double orphanhood over that expected by chance is shown in Figure IIb. It is independent of the absolute level of orphanhood – the slope of the best fit lines in Figure IIb is not significantly different from 1. Residual scatter of the survey estimates about the lines results from the impact of different levels of HIV and marriage patterns that affect the age differences of parents (both of which show a significant correlation with excess risk of double orphanhood in a Poisson regression analysis; data not shown). The excess risk of double orphanhood is greater for young children. Their parents also tend to be relatively young and those of them who have died are likely to die together in a catastrophic event such as an accident or from a fatal (directly transmitted) infection.

2. Projections of orphan numbers

Projections of orphan numbers based on mortality and fertility estimates show broad agreement with estimates from household surveys. Projections and survey estimates of the fraction of children by age who are orphans are shown for Tanzania in 1999 in Figure III. The relative prevalence of maternal, paternal and double orphans are closely matched, as is the rise in prevalence of orphans with age. The projections are higher than the survey estimates, particularly for maternal orphans (the survey estimates of maternal, paternal and double orphans are lower than the projections by 41%, 21% and 5% respectively). This is likely to reflect both an overestimate of mortality in the projections, and a failure to enumerate all orphans in the surveys, particularly maternal orphans (as discussed previously). A more detailed comparison of projections with household surveys from UNICEF as well as the DHS is presented elsewhere (Grassly and others, submit).

Surveys contain additional information about orphans, including characteristics of their households that are of relevance to policy (Bicego and others, 2003). Projections allow some other policy-relevant characteristics of orphans to be addressed, which are not reported in surveys. The most obvious of these is the fraction of children who are orphaned as a direct result of a parental AIDS death. In 1999 in Tanzania an estimated 4 out of 10 orphans were orphaned by AIDS (Figure IIIa). In sub-Saharan Africa as a whole the fraction of orphans who are AIDS orphans was estimated at 32% at the end of 2001 and is estimated to rise to 48% by 2010 (UNAIDS and others, 2002).

Projections can also provide estimates of orphans up to any age. The prevalence of orphanhood among children older than 14 years is currently inestimable from the DHS. Our projections show that among 15-17 year old children, the prevalence of orphanhood is even greater than at younger ages (Figure IIIa). In Tanzania in 1999, 15-17 year old children represent 13% of all children but include 24% of all orphans. This pattern exists throughout Africa and highlights the need to include such children in orphan statistics.

3. The impact of the HIV pandemic

a. Age distribution of orphans

The fraction of children who are orphans rises steeply with age (Table 1). However, in countries experiencing the initial impact of AIDS on adult mortality, orphans are relatively young, reflecting the youthfulness of parents dying from AIDS. Projections of AIDS orphans clearly show this pattern. In Tanzania the fractions of maternal, paternal or double orphans in 1990 who were under 6 years of age are

estimated at 30%, 36% and 24% respectively (Figure IV). By 2010 those children who were orphaned at a young age will have grown up and those under 6 years of age decline to represent just 14%, 18% and 9% respectively. The brief surge in the relative importance of young AIDS orphans has a slight, transient impact on the projected age distribution of orphans due to all causes (Figure IV). However, the age distribution does not shift significantly, with the fraction of orphans at younger ages showing a slight peak in 2000 before dropping back to pre-epidemic levels by 2010. Countries with more severe HIV epidemics than Tanzania, where HIV prevalence peaked at 10%, may show a slightly greater transient shift in the age distribution of orphans.

b. Double orphans

The ratio of children who are double orphans to those who are single orphans is higher in the DHS of countries with significant HIV epidemics as a result of sexual transmission of HIV between parents (Table 1). As the HIV epidemic progresses in a country the fraction of orphans whose parents have both died is expected to increase. Projections of orphan numbers in Tanzania show the extent of the increase in double orphanhood, from 7% of orphans in 1990 to 13% just 10 years later (Figure Va). Three different DHS have been implemented in Tanzania during the 1990s and these also reveal this increase in the prevalence of double orphanhood, rising from 6% in 1992 to 13% in 1999 (Figure Vb). These concurrent rises in the fraction of orphans whose parents have both died and the total number of orphans (right hand axis in Figure V), indicate a massive rise in the absolute number of double orphans as a consequence of the HIV epidemic.

c. Vulnerable children

Projections and household surveys can be used to examine the extent to which children have been made more vulnerable by HIV/AIDS to factors that compromise their welfare. Household surveys may be used to estimate numbers of children in households that have absorbed orphans or had to deal with the death of an adult, although the cause of death cannot be ascertained. Projections can be used to look more closely at the direct impact of HIV/AIDS on vulnerability as defined in a number of ways.

An obvious extension of the concept of vulnerable children beyond orphans is to include those children whose parents have AIDS. On average, adults suffer one year of terminal illness before death from AIDS (UNAIDS Reference Group on Estimates Modelling and Projections, 2002). Therefore this extended definition would shift the prevalence of age distribution of the prevalence of AIDS orphans to the left by one year. As a consequence the overall numbers of 'AIDS orphans and vulnerable children' increases. The greater the incidence of orphaning by age, the greater the increase in the number of vulnerable children. However, for a constant risk of orphaning by age, the relative increase remains roughly constant at 12-13% for children aged 0-14 years old for a range of values for the risk of orphaning (from 1 in 50 per child per year to 1 in 1000, ignoring the complication of the vertical transmission of HIV). In Uganda including children whose parents have AIDS in the definition of AIDS orphans would increase their numbers by 12% in 2002. Since AIDS orphans constitute a large fraction of all causes orphans in Uganda (57% at the end of 2002), the increase over all-cause orphans would be 7%. For countries where HIV prevalence is lower, the impact of the inclusion of vulnerable children defined in this way would be lower. Consideration of longer periods of illness before AIDS would shift the age distribution of AIDS orphans and vulnerable children towards progressively younger ages. As a consequence estimated numbers of 'vulnerable' children would rise.

D. DISCUSSION

The numbers of orphans in Africa has risen steeply in the last decade and will continue to rise as the number of adult AIDS deaths mounts. The orphaning of large numbers of children by AIDS is confirmed by household surveys, where countries with the highest prevalence of orphanhood tend to have the highest prevalence of HIV. Older children are more likely to be orphans since a longer time has elapsed

since their birth during which their parents have been exposed to the risk of dying. Previous statistics on the orphan crisis have failed to include children aged 15 years and over. However, these children typically represent one quarter of all orphans under the age of 18 years with little impact of the HIV pandemic on this pattern. Extending the definition of orphans to include all children under 18 years old would therefore increase the estimated 34 million orphans in Africa at the end of 2001 to 46 million.

The increase in the prevalence of orphans with age has several policy implications. For example, most orphans are of school age, with 9 out of 10 orphans being five-years old or older. Household surveys indicate that being an orphan is associated with premature withdrawal from school (UNAIDS and others, 2002; World Bank, 2002). A response from the education sector to keep orphans in school is therefore paramount if the Education for All targets are to be reached. Older children who are orphaned may also be more likely to be forced into child labour to support their adoptive households.

The HIV pandemic is orphaning millions of children and it is also increasing the fraction of these orphans whose parents have both died, particularly at younger ages. These children are arguably the most vulnerable. They are less likely to complete schooling than single orphans (UNAIDS and others, 2002). By definition their care, where provided, must come from an adoptive household where the resources devoted to them may be less than that available to the biological children of the adults in the household (Nyamupaka and Gregson, 2003). Double orphans may also be more likely to end up on the street than single orphans.

In addition to orphans, many other children are made vulnerable and their welfare compromised by the HIV/AIDS pandemic. For example, parental illness due to AIDS is likely to reduce a child's welfare because of loss of household income. This may manifest itself in malnutrition or withdrawal from school due to lack of school fees or to facilitate employment in informal jobs to supplement household income. Those children made vulnerable by AIDS in this sense, but who are not yet orphans, represent about 10% of the number of AIDS orphans. Extending the definition of the vulnerable to include children whose parents have some HIV-related illness other than AIDS would further increase this figure.

Children may also be made vulnerable and have their welfare compromised by HIV/AIDS in more indirect ways. For example, other children in households that have taken in orphans of family members may have reduced access to limited resources such as food or school fees. The impact of the HIV-related illness and death of health care professionals, teachers and civil servants may also increase children's risk of ill-health, malnutrition or poor education by degrading the quality of services. Ultimately the extent of vulnerability will depend on the choice of measures of welfare and the mechanisms through which HIV/AIDS impacts on child welfare. Some children may be vulnerable on several measures and through different mechanisms. Others will be made vulnerable in just one dimension through a particular adverse effect of HIV/AIDS. Additionally, vulnerability depends on the child's context. Becoming an orphan or having an ill family member may not compromise the physical health or education of some children in any way. Sufficient resources may be available in a household or extended family to mitigate the impact on them. Even these children, however, will suffer emotional distress and, perhaps, longer-term psychosocial problems. Vulnerability is therefore a nebulous concept as well as an important reality. It may not be amenable to the kind of accounting that can be used to enumerate orphans due to AIDS and other causes.

Projections and household surveys are useful in revealing the numbers and characteristics of orphans in Africa and the impact of the HIV pandemic on orphans and 'vulnerable' children. They can provide information about the ages of children orphaned, the status and location of their other parent, the cause of their orphaning, the features of the households that absorb them, and the impact on their enrolment in and attendance at school. This information may serve to inform the development of some programmes to support vulnerable and orphaned children, particularly those providing financial assistance. However, more detailed, context-specific accounts are also needed of the impact of orphanhood on children, from the illness of a parent, through the parent's death to the child's entry into adulthood (or death). Such

studies would give a clearer idea of the scale of the abuse suffered and psychosocial support needed by such children, the relative timing of these needs, and how support may best be delivered.

E. REFERENCES

- Bicego, G., S. Rutstein and K. Johnson (2003). Dimensions of the emerging orphan crisis in sub-Saharan Africa, *Social Science & Medicine*, vol. 56, No. 6, pp. 1235-1247.
- Brown, L. ed. (1993). *The New Shorter Oxford English Dictionary*. Oxford: Clarendon Press.
- Coale, Ansley J. and Paul Demeny (1983). *Regional Model Life Tables and Stable Populations*. London: Academic Press.
- Foster, G. (2002). Supporting community efforts to assist orphans in Africa, *New England Journal of Medicine*, vol. 346, No. 24, pp. 1907-1910.
- Foster, G. and J. Williamson (2000). A review of current literature on the impact of HIV/AIDS on children in sub-Saharan Africa, *AIDS*, vol. 14 (suppl. 3), pp. S275-S284.
- Grassly, N.C., J. J. C. Lewis, M. Mahy, N. Walker and I. M. Timaeus (submit). Comparison of survey estimates with UNAIDS/WHO projections of mortality and orphan numbers in sub-Saharan Africa.
- _____ and I. M. Timaeus (submit.). Orphan numbers in populations with generalised AIDS epidemics, *J. AIDS*.
- Monk, N. O. (2002). *Enumerating Children Orphaned by HIV/AIDS: Counting a Human Cost*. Boston: Association François-Xavier Bagnoud, <http://www.fxb.com>. Accessed 22nd July 2003.
- Nyamupaka, C. A. and S. Gregson (2003). Contrasting primary school outcomes of paternal and maternal orphans in Manicaland, Zimbabwe: HIV/AIDS and weaknesses in the extended family system. In *NIH Conference on AIDS and the Family*. Washington D.C.
- Timæus, I. M. (1998). Impact of the HIV epidemic on mortality in sub-Saharan Africa: evidence from national surveys and censuses, *AIDS*, vol. 12 (suppl. 1), pp. S15-27.
- UNAIDS, UNICEF and USAID (2002). *Children on the Brink 2002: A Joint Report on Orphan Estimates and Program Strategies*. Washington, D. C.: UNAIDS, UNICEF, USAID.
- UNAIDS Reference Group on Estimates Modelling and Projections (2002). Improved methods and assumptions for estimation of the HIV/AIDS epidemic and its impact: Recommendations of the UNAIDS Reference Group on Estimates, Modelling and Projections, *AIDS*, vol. 16, pp. W1-W16.
- UNAIDS/WHO (2002). *AIDS Epidemic Update 2002*: UNAIDS/02.58E.
- UNICEF and UNAIDS (2003). *Report on the Technical Consultation on Indicators Development for Children Orphaned and Made Vulnerable by HIV/AIDS Gaborone, Botswana, 2-4 April 2003*. New York: UNICEF.
- World Bank (2002). *Education and HIV/AIDS: a window of hope*. Washington, D.C.: World Bank. www.worldbank.org accessed 14th August 2003.

TABLE 1. PERCENTAGE OF CHILDREN ORPHANED BY AGE GROUP, 37 DEMOGRAPHIC AND HEALTH SURVEYS IN 26 COUNTRIES

Survey	Both parents dead					Mother only dead					Father only dead					Either or both parents dead					% HIV end-2001
	0-2	3-5	6-9	10-14	0-14	0-2	3-5	6-9	10-14	0-14	0-2	3-5	6-9	10-14	0-14	0-2	3-5	6-9	10-14	0-14	
Benin 1996	0.0	0.1	0.5	0.5	0.3	0.3	1.1	2.7	3.9	2.2	1.4	2.8	3.8	7.7	4.1	1.7	4.0	7.0	12.1	6.6	3.6
Benin 2001	0.0	0.0	0.6	1.0	0.5	0.3	1.0	1.5	2.6	1.4	1.0	2.3	4.5	8.1	4.3	1.3	3.3	6.6	11.7	6.2	3.6
Burkina Faso 1992	0.0	0.6	1.1	1.9	1.0	0.5	1.1	2.6	3.8	2.2	1.9	2.9	5.0	7.2	4.5	2.4	4.6	8.7	12.9	7.7	6.5
Cameroon 1991	0.0	0.1	0.3	1.1	0.4	0.3	1.1	2.1	3.3	1.8	1.3	2.8	4.9	8.0	4.5	1.6	4.0	7.3	12.4	6.7	11.8
Cameroon 1998	0.2	0.2	0.5	1.3	0.6	0.3	1.1	2.9	3.8	2.3	1.6	3.4	6.6	10.4	6.0	2.1	4.7	10.0	15.5	8.9	11.8
CAR 1994	0.0	0.2	0.9	1.9	0.8	0.6	1.9	4.2	4.8	3.0	1.7	4.7	7.7	10.9	6.6	2.3	6.8	12.8	17.6	10.4	12.9
Chad 1997	0.1	0.3	0.7	0.9	0.5	0.3	1.2	2.6	3.3	2.0	1.6	3.3	5.5	8.4	4.9	2.0	4.8	8.8	12.6	7.4	3.6
Cote d'Ivoire 1994	0.1	0.1	0.4	0.8	0.4	0.2	1.1	2.0	2.8	1.6	1.5	2.5	4.5	7.0	4.0	1.8	3.7	6.9	10.6	6.0	9.7
Eritrea 1995	0.0	0.3	0.7	1.5	0.7	1.0	2.7	4.8	5.6	3.8	0.9	4.4	8.2	12.5	7.2	1.9	7.4	13.7	19.6	11.7	2.8
Ethiopia 2000	0.1	0.3	1.0	1.6	0.8	0.7	2.0	3.4	5.9	3.2	1.5	3.6	7.2	11.6	6.5	2.3	5.9	11.6	19.1	10.5	6.4
Gabon 2000	0.1	0.0	0.5	0.8	0.4	0.5	1.5	2.6	3.2	2.1	1.2	2.7	3.2	5.7	3.3	1.8	4.2	6.3	9.7	5.8	...
Ghana 1998	0.0	0.1	0.4	0.9	0.4	0.4	1.0	2.7	2.9	1.9	0.9	2.4	4.2	5.5	3.6	1.3	3.5	7.3	9.3	5.9	3.0
Guinea 1999	0.2	0.5	0.9	1.5	0.9	0.4	1.1	2.8	3.0	2.1	1.6	3.1	5.5	8.0	4.9	2.2	4.7	9.2	12.5	7.9	...
Kenya 1993	0.1	0.1	0.4	0.3	0.3	0.3	0.9	1.6	2.2	1.4	2.7	3.6	5.7	7.4	5.2	3.1	4.6	7.7	9.9	6.9	15.0
Kenya 1998	0.1	0.5	0.8	1.7	0.9	0.4	1.3	2.0	2.6	1.8	3.4	3.6	7.7	9.7	6.6	3.9	5.4	10.5	14.0	9.3	15.0
Malawi 1992	0.1	0.9	1.1	1.9	1.1	0.5	3.0	3.3	4.7	3.1	1.9	3.5	5.3	6.6	4.6	2.5	7.4	9.7	13.2	8.8	15.0
Malawi 2000	0.1	0.6	1.8	4.3	1.9	0.3	1.5	3.6	5.5	3.0	2.0	4.4	7.6	10.8	6.4	2.4	6.5	13.0	20.6	11.3	15.0
Mali 1996	0.1	0.3	0.4	0.8	0.4	0.3	1.1	2.1	3.0	1.7	1.2	2.1	3.6	6.2	3.4	1.6	3.5	6.1	10.0	5.5	1.7
Mali 2001	0.0	0.4	0.7	1.0	0.6	0.2	0.8	1.6	3.0	1.5	1.2	2.4	3.3	5.1	3.1	1.4	3.6	5.6	9.1	5.2	1.7
Mauritania 2001	0.2	0.5	0.8	1.4	0.8	0.7	1.5	2.3	3.4	2.2	1.5	2.5	4.3	6.8	4.2	2.4	4.5	7.4	11.6	7.2	...
Mozambique 1997	0.1	0.3	0.5	2.6	1.0	0.8	1.8	4.9	7.6	4.3	2.6	4.0	6.8	11.6	6.7	3.5	6.1	12.2	21.8	12.0	13.0
Namibia 1992	0.0	0.1	0.3	1.2	0.4	0.5	0.9	2.0	2.4	1.6	1.5	3.2	5.6	9.3	5.1	2.0	4.2	7.9	12.9	7.1	22.5
Niger 1992	0.0	0.1	0.2	1.0	0.4	0.3	1.7	2.6	5.5	2.7	0.8	1.9	4.4	7.0	3.7	1.1	3.7	7.2	13.5	6.8	...
Niger 1998	0.0	0.3	0.2	0.6	0.3	0.4	1.4	2.6	3.6	2.0	0.6	2.4	3.5	6.4	3.2	1.0	4.1	6.3	10.6	5.5	...
Rwanda 1992	0.2	0.2	0.7	1.4	0.7	0.5	1.9	2.2	3.8	2.3	2.3	4.9	7.5	10.2	6.5	3.0	7.0	10.4	15.4	9.5	8.9
Senegal 1993	0.1	0.3	0.3	0.6	0.4	0.3	1.0	1.5	3.4	1.7	1.6	3.0	4.6	6.7	4.1	2.0	4.3	6.4	10.7	6.2	0.5
South Africa 1998	0.2	0.4	0.6	1.3	0.8	0.5	1.0	1.3	2.1	1.4	2.9	6.0	7.9	11.2	7.7	3.6	7.4	9.8	14.6	9.9	20.1
Tanzania 1992	0.0	0.1	0.5	1.0	0.4	0.3	1.2	2.3	3.3	1.9	1.8	3.4	5.3	7.5	4.6	2.1	4.7	8.1	11.8	6.9	7.8
Tanzania 1996	0.0	0.3	0.7	1.1	0.6	0.3	1.3	2.3	4.3	2.3	1.7	3.8	6.1	9.3	5.6	2.0	5.4	9.1	14.7	8.5	7.8
Tanzania 1999	0.0	0.3	1.4	2.1	1.1	0.4	0.9	3.1	4.1	2.3	1.4	3.1	6.0	9.4	5.3	1.8	4.3	10.5	15.6	8.7	7.8
Togo 1998	0.0	0.3	0.7	1.1	0.6	0.4	1.2	2.8	3.6	2.3	1.8	3.3	5.8	10.6	6.0	2.2	4.8	9.3	15.3	8.9	6.0
Uganda 1995	0.1	1.0	2.2	3.8	1.9	0.4	2.2	4.0	5.0	3.0	2.5	5.7	9.4	13.9	8.0	3.0	8.9	15.6	22.7	12.9	5.0
Uganda 2001	0.2	0.9	2.4	4.9	2.3	0.4	1.5	3.4	5.3	2.9	1.8	4.9	8.2	12.7	7.2	2.4	7.3	14.0	22.9	12.4	5.0
Zambia 1992	0.0	0.1	0.7	1.3	0.6	0.6	1.3	3.0	3.3	2.2	1.8	3.6	5.4	8.3	5.1	2.4	5.0	9.1	12.9	7.9	21.5
Zambia 1996	0.0	0.7	1.6	3.1	1.5	0.4	2.1	3.5	4.6	2.9	2.6	5.4	8.6	11.7	7.3	3.0	8.2	13.7	19.4	11.7	21.5
Zimbabwe 1994	0.2	0.3	0.7	1.3	0.7	0.5	1.1	1.9	3.0	1.9	2.0	4.6	6.7	10.1	6.5	2.7	6.0	9.3	14.4	9.1	33.7
Zimbabwe 1999	0.2	1.0	2.3	3.7	2.1	0.9	1.3	2.7	3.8	2.6	3.0	6.8	10.9	14.1	9.3	4.1	9.1	15.9	21.6	14.0	33.7
<i>Average</i>	<i>0.1</i>	<i>0.3</i>	<i>0.8</i>	<i>1.6</i>	<i>0.8</i>	<i>0.4</i>	<i>1.4</i>	<i>2.7</i>	<i>3.8</i>	<i>2.3</i>	<i>1.8</i>	<i>3.6</i>	<i>6</i>	<i>9</i>	<i>5.4</i>	<i>2.3</i>	<i>5.3</i>	<i>9.5</i>	<i>14.5</i>	<i>8.5</i>	<i>10.5</i>

A. FIGURE LEGENDS

Figure I Percentage of children orphaned by age in years, 37 Demographic and Health Surveys. The bars indicate the interquartile range and the lines the 10th and 90th percentiles of the distribution.

Figure II Relationship between maternal, paternal and dual orphanhood, 37 Demographic and Health Surveys. In **a)** the percentage of children with dead mothers is plotted against the percentage of children with dead fathers with the area of the circles represents the percentage of children whose parents have both died. In **b)** the percentage of children where both parents have died is plotted against the percentage expected if parental deaths were independent, both on a log scale. For each age group a straight line on the log scale (power law) is fitted. A line showing equivalence of observed and expected dual orphanhood is also plotted for reference.

Figure III Fraction of children who are maternal (M), paternal (P) or double (D) orphans by age for Tanzania **a)** projected by a simple model and **b)** estimated in the DHS, 1999.

Figure IV Projected age distribution of children whose mother only (**a, d**), father only (**b, e**) or both parents (**c, f**) have died from AIDS (**a-c**) or all causes (**d-f**) for 1990 to 2010 in Tanzania. The total number of such orphans are plotted on the right hand axes.

Figure V Distribution of orphans in Tanzania according to parental survival **a)** projected over 1990 to 2010, and **b)** estimated from the DHS for 1992, 1996 and 1999. The total numbers of orphans from all causes are plotted on the right hand axes.

Figure I

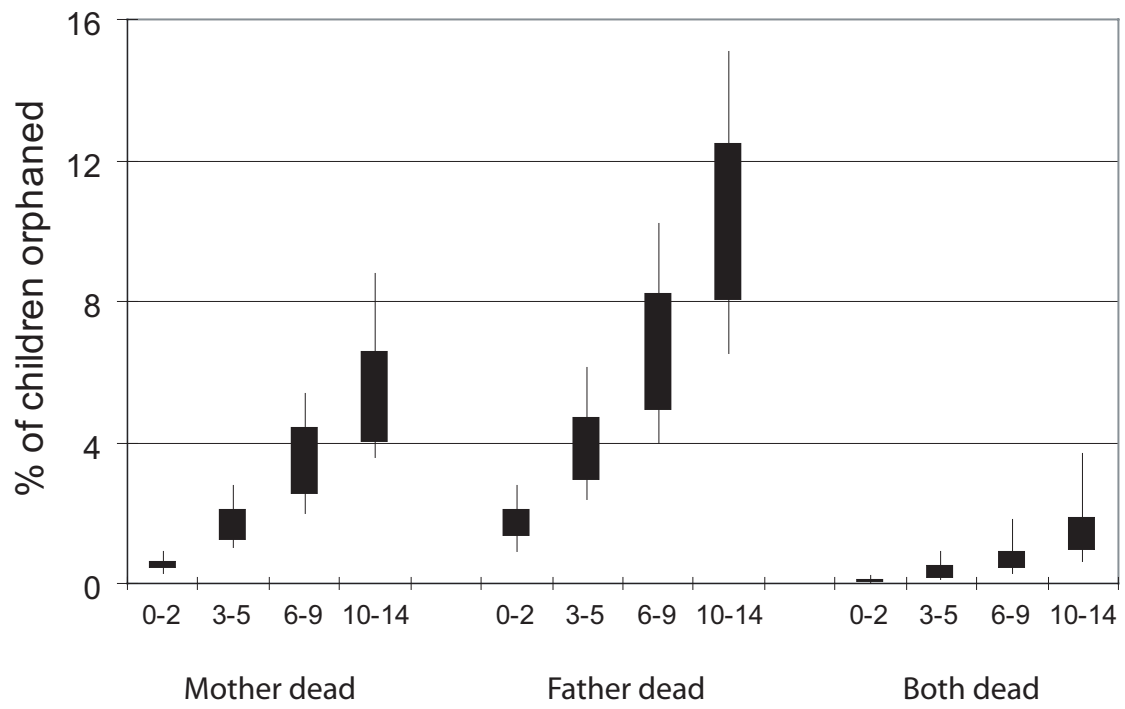
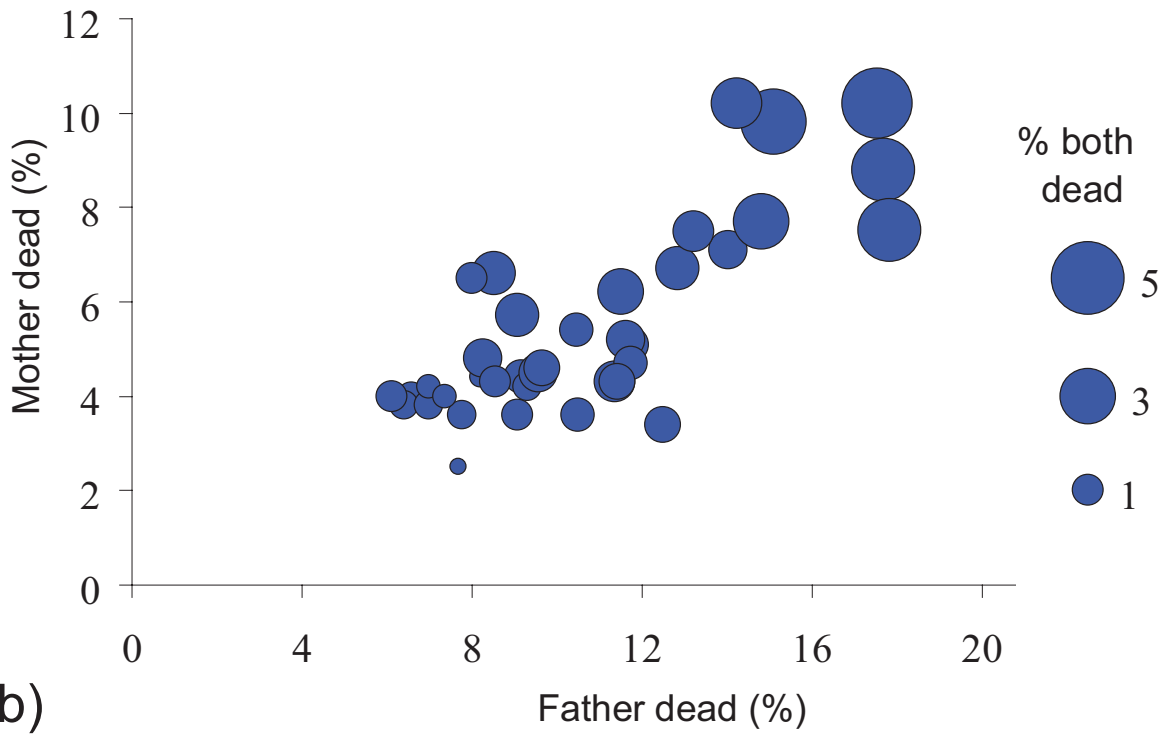


Figure II

a)



b)

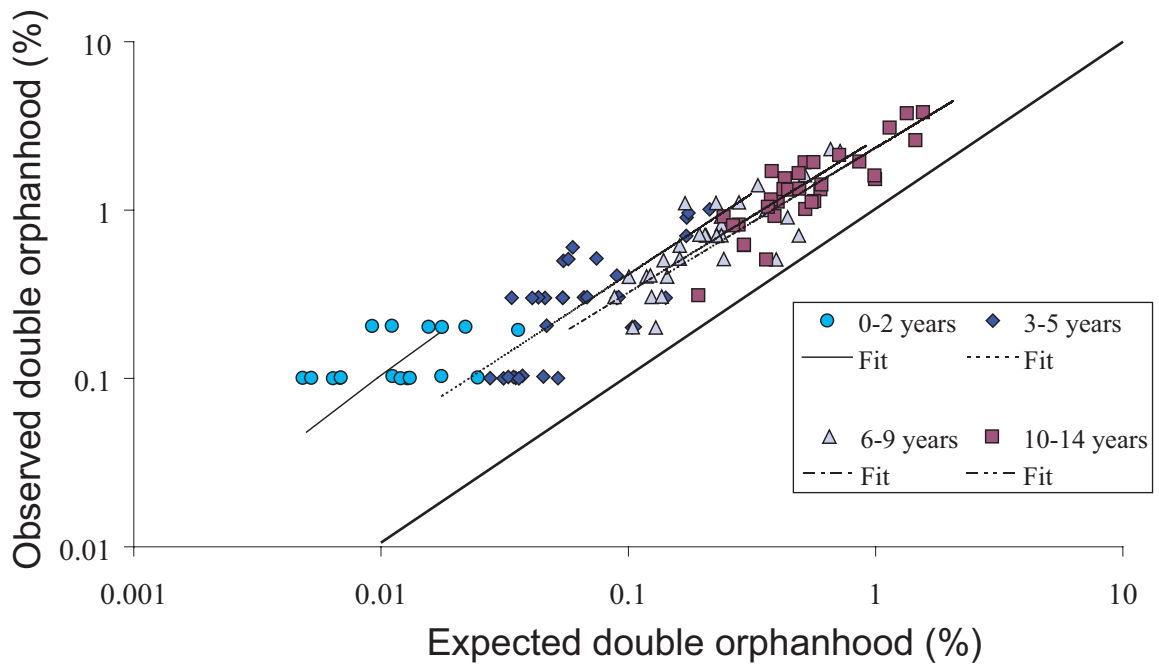
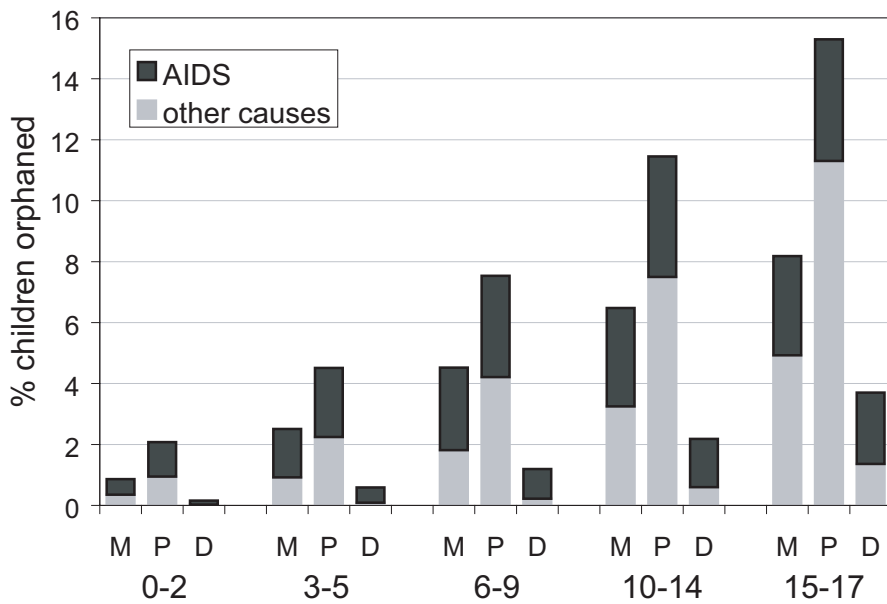


Figure III

a)



b)

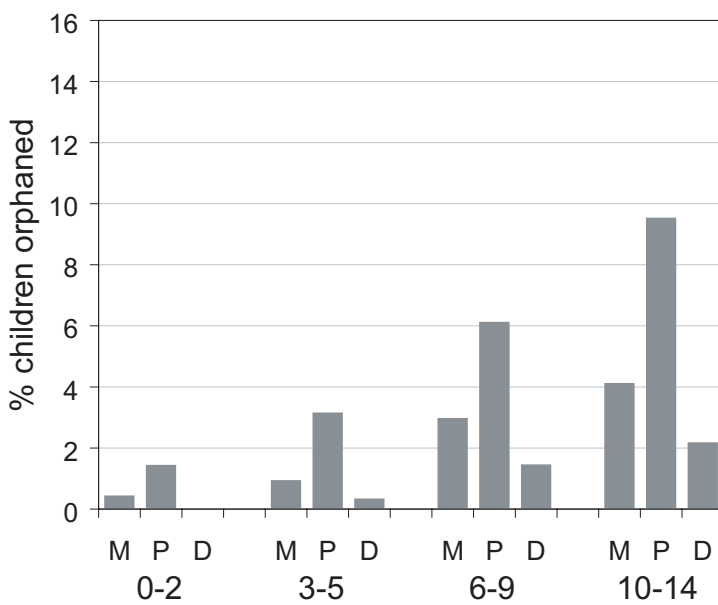


Figure IV

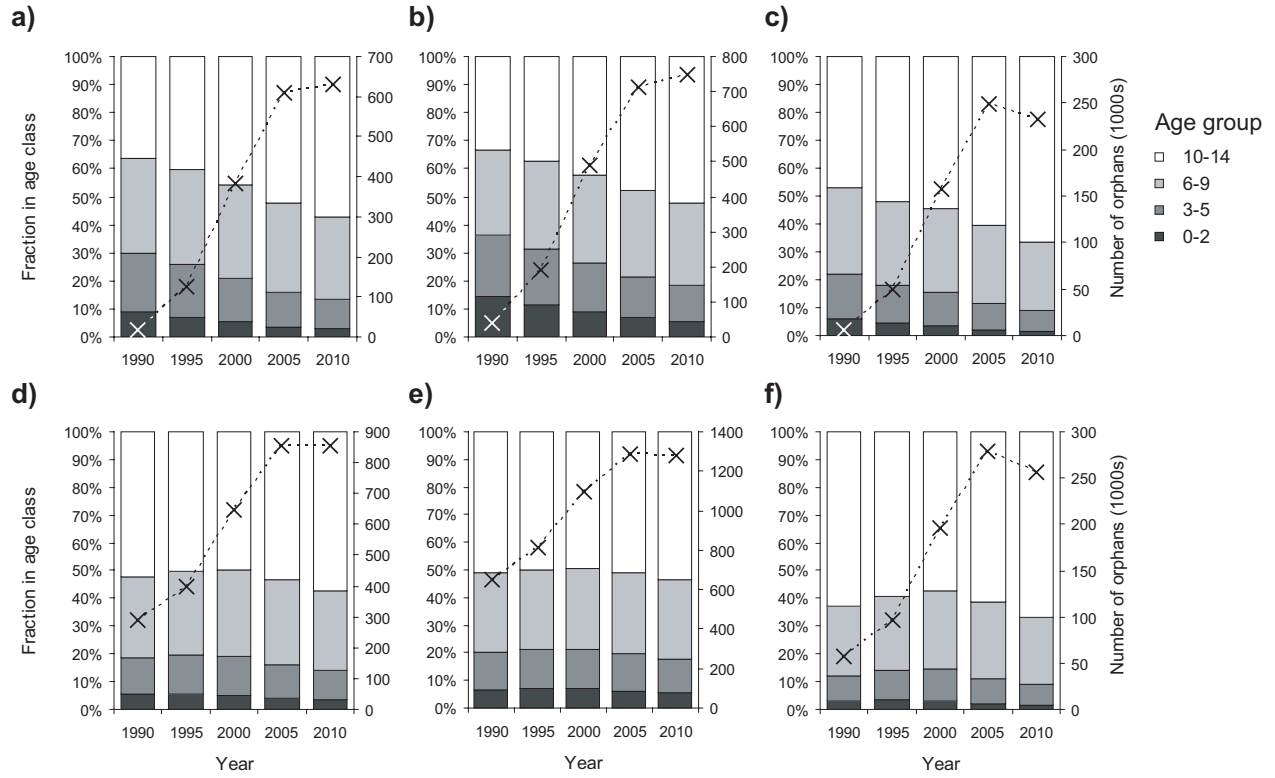


Figure V

