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MEASURING CHILD MORTALITY IN AIDS-AFFECTED COUNTRIES *

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A. INTRODUCTION

Recent estimates show that over the past decade there has been a stagnation and reversal in the previous gains made in child mortality in some countries. HIV/AIDS is thought to be an important cause of this reversal of trends (Walker and others, 2002; Nicoll and others, 1994). At the same time, current methods of measuring child mortality in low resource settings are compromised because of the association between child and maternal mortality in settings with high AIDS prevalence. Children whose mothers have died have higher child mortality (Nakinyingi, 2003a). This association results in a bias in reported child deaths in data collected retrospectively from mothers because only living mothers are able to report.

In 2001 UNICEF funded the London School of Hygiene and Tropical Medicine (LSHTM) to assess the impact of the HIV epidemic on child mortality. One component of that study was to evaluate current methods for estimating child mortality in high HIV prevalence countries. That component is the focus of this paper. Reports on the full project can be found elsewhere (Zaba and others, 2003). This paper presents a brief overview of the impact of AIDS on child mortality trends and summarizes the research on the effects of AIDS on measuring child mortality. The effects of AIDS on both indirect and direct estimation of child mortality are discussed. In conclusion, recommendations are made for surveys measuring child mortality in AIDS-affected countries.

B. OVERVIEW OF THE IMPACT OF AIDS ON CHILD MORTALITY

A number of studies have pointed to increased child mortality as a result of the AIDS epidemic. This is a natural conclusion based on the evidence that vertical transmission of HIV occurs in approximately 32 percent of births to HIV infected mothers in countries where breastfeeding is prevalent (Walker, 2003). And 60 percent of children who are infected with HIV will die before their fifth birthday (Spira and others, 1999). However, questions about what proportion of the increase in child mortality is due to vertical transmission and what proportion is due to other factors (including those related to a countries' HIV epidemic) are still being debated.

At the aggregate level, Adetunji (2000) reviewed Demographic and Health Survey (DHS) data from 25 countries and found increases in under five mortality levels in countries with prevalence over five percent. But he concluded that not all of the stagnation in child mortality can be directly attributed to the prevalence of HIV/AIDS and was not able to separate the effects from AIDS and from other causes. Walker and others (2002) estimated the increase in child mortality due to HIV/AIDS in Sub-Saharan Africa and determine that HIV is not the only cause of the increase in child mortality – they go on to find that correcting for competing causes of mortality, HIV infection caused eight percent of under-five deaths in 1999. More recent research by Walker and Ghys (2003) estimated that ten percent of child mortality in sub-Saharan Africa was due to HIV infection.

It is evident that some of the increase in child mortality is due to direct transmission from mother to child, and some of it is caused by indirect effects due to maternal illness or maternal death (Ng'weshemi, 2003). The resurgence of malaria and lower levels of vaccination coverage and health care utilization are also contributing to the reversal in child survival trends (Rutstein, 2000). These negative trends in high prevalence settings could be due to an overload on health resources due to AIDS.

Research by Hill and others (2001) attempted to tease out the causes for a 25 percent increase in under-five mortality in Kenya between the late 1980s and the mid-1990s. Provincial level HIV prevalence was included as a key variable to analyse the factors associated with an increase in child mortality. HIV prevalence in a community was found to be associated with an increase in child mortality. A number of control variables were used in the analyses including social, bio-demographic and health sector factors and even while controlling for these HIV was found to be significant suggesting that the direct effect was important.

Finally Crampin and others (2003) used data from a longitudinal study site in Malawi to measure child mortality to HIV positive women versus HIV negative women. They found significantly different under-five mortality levels for HIV-positive mothers (46 percent) versus HIV-negative mothers (16 percent). Whether this increased mortality is due to vertical transmission or to the negative impacts of an ill parent are not distinguished. However, this is clear evidence for a correlation between mother and child mortality in high HIV-prevalence settings.

Given the various direct and indirect influences of HIV on child mortality and the substantial levels of population attributed risk to HIV, it is critical to continue to closely monitor child mortality. Thus, it is crucial to understand any possible shortcomings of current child mortality estimation methods.

C. Measuring Child Mortality

Estimates of child mortality in developing countries are usually derived from retrospective reporting by women captured in household surveys or censuses. The two major surveys that estimate child mortality are the Demographic and Health Surveys (DHS) and the Multiple Indicator Cluster Surveys (MICS). DHS collects birth histories from women and estimates child mortality through direct techniques. Women are asked about each of their live births and whether the child is currently alive or not. Child mortality is then directly measured from the women's retrospective reporting. MICS, and many censuses, use an indirect method asking women about the number of live births they have ever had and the number of births that are currently alive. An indirect estimation technique is then used based on the mother's age to estimate child mortality at different time points in the recent past.

Both methods are based on the assumption that women's mortality is not correlated with their children's mortality. If the two were correlated than as women died, and were not captured in the household survey, there would be a bias in the child mortality estimates.

Indirect estimation methods are used to calculate child mortality in developing countries where comprehensive surveys have not been conducted. In these countries governments rely on census data or MICS surveys for child mortality estimates. The indirect technique for calculating child mortality requires fewer and simpler questions resulting in substantial cost savings. The indirect method is based on six questions per woman, while the direct method requires a full birth history including about six questions per child of each woman. Birth histories include dates of birth and deaths (where applicable) which can be difficult and time consuming for women to recall. The interviewer training required for the indirect methods is also substantially less for a number of reasons, including that for birth histories interviewers are often required to calculate dates from ages or ages from dates.

D. The Effect of AIDS on Child Mortality Estimates

In a low HIV-prevalence setting this is not likely to affect the estimates of child mortality. However, this assumption is violated in a high HIV prevalence setting. There is correlation between maternal and child mortality because of vertical transmission of the disease and because of an indirect increase in child mortality if the mother is sick or has died (Ng'weshemi, 2003; and Nakiyingi, 2003b). The child mortality of women who are infected with HIV is higher than women who are not infected (Crampin 2003). If a mother had died of AIDS her children have a higher chance of being HIV positive and thus they would be under-represented.

1. Indirect Estimation Methods

For the indirect technique the proportion of children who have died by age group of the mother (15-19, 20-24, …45-59) is calculated and an estimate of the probability of dying between birth and various ages is estimated from these calculations. The proportion dead can then be translated to mortality at different points in time over the years prior to the survey. The result is estimates of child survival to different ages, and corresponding to different points in time. (For a complete description of this technique see UN Manual X, United Nations, 1983)

The indirect technique relies on a number of assumptions including: 1) the correlation of mortality between mother and child is sufficiently small to ignore, 2) child mortality is independent of mother's age, and 3) the child mortality pattern can be described using a model life table. The first assumption is violated in countries with high levels of vertical transmission of HIV. As explained before, HIV positive mothers are more likely to have HIV positive children and since the case fatality is so high for HIV positive individuals a correlation exists between child and maternal mortality. The second assumption is violated also in HIV settings because in most countries HIV prevalence is associated with mother's age, thus child mortality is not independent of mother's age. In the normal application of indirect estimation this is also violated, however in the high HIV prevalence situation the discrepancy is larger. And finally, currently available life table models do not emulate current mortality situations in AIDS affected countries, especially at ages two through four. Empirical data find much higher levels of child mortality in relation to infant mortality in HIV-affected countries than what is predicted in the model life tables. Thus finding a suitable life table based on available parameters could either lead to an inappropriate model life table or no life table match the available parameters.

Ward and Zaba (2001) created a model to estimate the potential bias from using indirect estimation methods. To simplify the model, they used a stable population (assuming no changes in mortality, or that HIV incidence would be constant over time) and estimated the bias in different HIV prevalence settings. They found that a number of key characteristics determine how much error is in the estimate. The prevalence of HIV determined the size of the error, while the level of background mortality determined the proportionate importance of the error. They found a significant bias in the estimate of child mortality even at prevalence levels as low as five percent. In the normal application of the indirect method only the data for age groups 20-24 to 34-39 are used. Table 1 suggests however that results from the two older age groups will present biases over 5 percent prevalence and in the lower two age groups the bias will appear at 10 percent prevalence.

Table 1. HIV prevalence that will produce an error of five percent or more in child mortality estimates based on reports of mothers aged:

Age group	15-19	20-24	25-29	30-34	35-39	40-44	45-49
Prevalence	10.3	10.9	9.4	4.8	4.8	3.8	1.9

Source: Ward and Zaba, 2002.

They attempted to calculate correction factors for indirect methods in various settings. However their model had a number of assumptions and simplifications resulting in an unrealistic model. The assumption about a stable population is currently not viable as it suggests that HIV incidence is constant over time. Incidence is associated with prevalence and as prevention interventions take place, incidence changes. Given that the errors are large in the model based on a stable population, it can safely be assumed the errors will be worse in a situation of changing incidence, mortality, and fertility. In addition, the estimation of the correction factors relied on estimations of the level of vertical transmission and mean survival time of adults with HIV. Both of these will fluctuate as a result of interventions providing anti-retrovirals (ARVs) to pregnant infected women to slow down vertical transmission and providing HAART to HIV positive women increasing their survival time.

Despite efforts to create correction factors, the assumptions and simplifications required for the model make the correction factors difficult to apply. Their conclusion was that countries with high prevalence should not use indirect estimates of child mortality.

2. Direct Estimation Methods

Direct estimation methods require collecting birth histories from women including the date of birth and date of death of every child. This data allows relatively accurate estimates of child mortality by time period and the age of the child. This technique does not use life table models nor does it rely heavily on data from women about births that occurred in the distant past. This makes the child mortality estimates more reliable, although there are still margins of error based on the size and sampling of the survey.

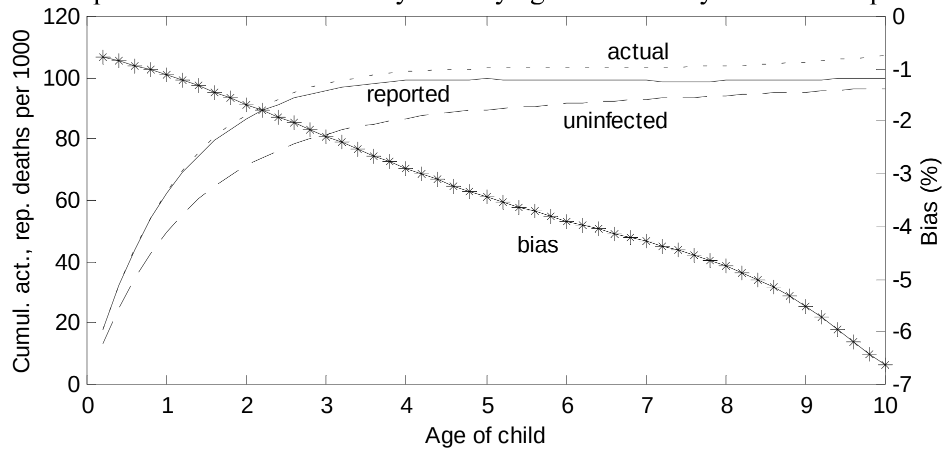
Similar to the indirect method, this method also relies on the assumption that maternal and child mortality are independent. However, this assumption is relied upon to a much smaller degree, especially for more recent estimates of child mortality. In addition the direct method does not use model life tables and does not depend on the mother's age. For these reasons there is a different effect of AIDS on the direct methods of estimating child mortality as compared to the indirect effect.

Artzrouni and Zaba (2003) looked at the bias introduced by AIDS when using direct estimation techniques. The duration since onset of the epidemic was included in the model because the survival function of the mother will be related to the time since infection. This model did not take into account the variable timing of survival based on the introduction of antiretroviral drugs or improved nutritional and care status of mothers. However we can infer that these two components will reduce the bias by keeping mothers alive longer.

The model measured the different mortality experience of infected and uninfected women and calculated the magnitude of the bias between the mortality risks in five settings. The settings incorporate various degrees of HIV prevalence and disease spread. Unfortunately they were all based on settings with low child mortality. In further analysis (personal correspondence) the authors find that there is a very small – 2 percentage point – increase in the estimate of bias in situations of higher underlying mortality.

Even at high prevalence levels they found that overall child mortality rarely exceeds five percent for the most recent time period (over the previous five years). Figure I presents the estimated bias 25 years into an epidemic. The same model for 35 years into the epidemic suggests there will be about a seven percent bias at age five. The more far reaching estimates of child mortality are less reliable given that only living mothers responded to the survey. Current confidence intervals around child mortality estimates from DHS surveys range from +/-5 percent to +/-13 percent suggesting that this bias will have little effect overall, however, the direction is known – the estimate is approximately five percent *under* the true value.

Figure I. Reported and actual mortality rates by age of child 25 years into an epidemic



Source: Artzrouni and Zaba, 2003.

This estimate was confirmed in three different longitudinal studies in which the highest bias was seven percent. The three sites had information on child deaths during a five year interval and the survival status of the mother at the end of the interval. Using this information it was possible to calculate the deaths that would have been missed due to the death of a mother. In two of the examples where prevalence was declining and slowly increasing the bias was three and two percent respectively. However in the site where the epidemic was increasing rapidly there was a seven percent bias.

The conclusion from this research is that it is not worthwhile correcting for this error in direct estimates because the error is only in the magnitude of at most five to seven percentage points. This is not enough of a difference to warrant a systematic adjustment. There is a significant bias if the data are used for births that occurred more than five years before the survey. Thus the estimates based on birth histories should be calculated only for the most recent five year time period.

E. IMPLICATIONS FOR SURVEYS MEASURING CHILD MORTALITY

Both estimation procedures assume that child and maternal mortality are not correlated however, the overall affect of this assumption on the direct estimation method is less substantial for estimates of mortality within five years of the survey than for the indirect method. In addition only one of the major assumptions for the direct estimation procedure is violated as opposed to three major assumptions being violated for the indirect procedure. For this reason the bias introduced in a high prevalence HIV setting is less significant when using direct estimation techniques.

The Ward and Zaba research is critical for understanding the ramifications of using indirect methods of estimating child mortality for these surveys. The conclusions suggest that indirect estimates will have substantial errors in countries where there are higher levels of HIV prevalence (> five percent). Although a significant attempt was made to calculate correction factors for this method, the assumptions made for the models were not relevant for current settings, thus they conclude "the corrections should not be relied upon to provide accurate corrections in real populations currently undergoing an epidemic of HIV."

UNICEF intends to conduct another round of MICS in mid-2004 - 2005. Questionnaire design for this round will take place in the next few months. MICS in general take place in countries with very little other data available (no recent DHS or other surveys). The indirect methodology will still be appropriate for the majority of countries in this round of surveys; however the questionnaire should be adjusted for countries with high prevalence of mortality. The resource implications of using birth histories are significant, so it will be important to advise countries to collect birth history data only in countries where no other accurate, current estimates of child mortality are available. Another possible resource saving solution might be to limit the birth history to births in the past seven years instead of doing complete birth histories.

The findings by Artzrouni and Zaba have implications for the direct estimation methods used in the demographic and health surveys and other reproductive health surveys. These estimates will be slightly underestimates but not by more than a five to seven percent difference. This difference is not more than the error already introduced by sample design, although we know the direction of the error imposed by the HIV bias. In addition, the research found that these errors increase for data from older women that respond to estimates further before the survey. Thus, estimates of child mortality using birth histories should not calculate estimates for time periods earlier than five years prior to the survey or for mortality estimates for children over five years of age when HIV prevalence among pregnant women is over five percent. This conclusion is verified by empirical evidence from a longitudinal study in Uganda that suggests that only four percent of mothers died within five years of giving birth (Nakiyingi, 2003b).

Future trends in child mortality should be carefully monitored and analysed with available data to determine how to take action against losses in child survival. Measurement of child mortality and analysis of cause specific mortality will provide programmers with information on where to allocate resources and focus efforts to reduce child mortality and reach the millennium development goal of reducing child mortality by two-thirds by 2015.

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