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Estimating Childhood Mortality from Census Data in Africa: The case of Zambia

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ACAP Working Paper No 11, August 1999

This research was done as part of ACAP activities. ACAP is supported by grants from the Rockefeller Foundation (RF 97013 #21; RF 98014 #22), the Andrew W. Mellon Foundation, and the Fogarty International Center and the National Institute of Child Health and Human Development (TW00655-04). The authors would like to thank Timothy Cheney for computer programming assistance.

Recommended citation:

Bawah, A. Ayaga and Tukufu Zuberi. 1999. Estimating Childhood Mortality from Census Data in Africa: The case of Zambia. ACAP Working Paper No 11. August 1999. The African Census Analysis Project (ACAP), Population Studies Center, University of Pennsylvania, Philadelphia, Pennsylvania.

Abstract

Africa continues to lack the data for direct estimates of infant and child mortality. Estimation of infant and child mortality in Africa has been based on Brass-type indirect methods. This paper seeks to utilise an extension of the Brass method proposed by Preston and Palloni—known as the "own-child" method— to estimate infant and child mortality using the 1990 Zambia national census data. The own-child method is able to map out the fertility history of women and therefore provides additional information about when children were born, and increasing the precision in estimating mortality. Additionally, this procedure is insensitive to declining fertility or irregular patterns of fertility that might have occurred in the past. The results provide a good basis for the application of the method for further mortality analysis using African census micro-data, especially differentials by subgroups within the population.

Introduction

Despite the general mortality decline witnessed almost everywhere in the world, the level of infant and child mortality remains relatively high in Africa (Hill, 1993; Timaeus, 1997; United Nations, 1994). Declines in infant and child mortality levels witnessed during the 1960s and 1970s have either stagnated or reversed their declining trend (Hill, 1993; Caldwell, 1997; Nicoll et al, 1994; Timaeus, 1997, 1999). For instance, results from the 1992 and 1996 Zambia Demographic and Health Surveys (ZDHS) (published 1993 and 1997 respectively) and micro-level data (Clark, 1999) show that infant and child mortality levels in Zambia stagnated in the late 1970s and have taken an upward turn since the early 1980s. The 1997 ZDHS report indicates that infant mortality rates in Zambia increased from 90 per 1000 in 1984 to 109 per 1000 in 1996, while under-five mortality increased from 167 per 1000 to 197 per 1000 during the same period.

This situation contrasts sharply with other third world countries, especially those of Asia and Latin America where infant and child mortality levels continue to decline monotonically. It is not clear what factors may have accounted for the recent deterioration in mortality conditions in sub-Saharan Africa. While some researchers speculate that this might be due to the HIV/AIDS epidemic, others argue that economic dislocations and trade imbalances in the mid-to–late-1980s through the 1990s, may account for the worsening mortality conditions (Hill, 1993; Nicoll et al, 1994; Caldwell, 1997; Timaeus, 1997; Timaeus, 1999; Clark 1999). Levels of infant and child mortality are of major concern to both the policy community and researchers alike because, apart from being measures of socio-economic development, children serve as the potential human capital of every nation. Secondly, knowledge of levels and trends of infant and child mortality helps to evaluate the effects of health intervention programs (Ewbank and Gribbles, 1993). For this reason there continues to be growing interest in finding more reliable methods of estimating levels, trends and determinants of childhood mortality.

Estimation of mortality at infancy and childhood in most parts of Africa has largely been based on the Brass-type indirect methods applied to survey data (Brass et. al., 1968; van de Walle and Heisler, 1980). The use of these methods followed Brass's revolutionary development of an ingenious technique that utilises information from retrospective questions on the number of children ever born and those surviving or dead to estimate fertility and mortality levels in data deficient circumstances. These indirect methods became particularly popular in sub-Saharan Africa following the publication of *The Demography of Tropical Africa* in 1968 by Brass and his colleagues, in which the methods were applied to African census/survey data. Subsequently, the United Nations adopted these methods and recommended the inclusion of questions on children ever born and/or dead in the censuses of developing countries.

Although there are now different variants of the original Brass procedures (Coale and Trussell, 1974; Sullivan, 1972; Trussell, 1975; Preston and Palloni, 1978; Palloni and Heligman, 1986), most of these are still based on the original Brass formulation. Brass used standard mortality and fertility models and established that the proportion of children dead for women aged x at the time of a census or survey **($\mathbf{D_x}$)** can be used as an approximation of the probability of dying from birth to age $\mathbf{a_x}$ (a_x ranging from 0 to $x-\alpha$):

$$Dx = \frac{\int_{\alpha}^{x} f(y)q(x-y)dy}{\int_{\alpha}^{x} f(y)dy} \cong q(a_x),....(1),$$

where ***x*** is defined as the exact age of a woman at the time of the survey or census, **f(*y*)** as the age-specific annual fertility rate for age **y**, and **q(*x–y*)** as the probability of a child's death in the interval from birth to age ***x–y***.

The above relationship implies that the proportion dead is a function of both mortality and fertility levels (i.e., the distribution of children born to women in their lifetime up to the time of the census or survey). Specifically, the proportion of children dead among those ever born can be written as:

$$Dx = \frac{D}{B} = \int_{0}^{\alpha} \frac{B(a)q(a)da}{B} = \int_{0}^{\alpha} c(a)q(a)da,....(2)$$

where ***D*** is defined as the total number of children dead of those ever born and B refers to the total number of children ever born to the reporting women. ***B(a)*** refers to the number of children ever born ***a*** years ago to those women, ***c(a)*** is the proportion of children ever born ***a*** years ago to the reporting women, and ***q(a)*** is the probability of death before age ***a*** to children born ***a –years*** ago to reporting women.

A major assumption of the Brass method is that fertility and mortality have remained constant in the recent past (Brass, 1975; United Nations, 1983). Following this assumption, it is possible to compare the cumulative fertility rates of women in different age categories and to infer the shape of the fertility function that is assumed to apply in the past to women of a certain current age. The observed cumulative fertility rates can then be used with adjustment multipliers derived via simulation, to estimate the proportion of children born *x* years ago who have died.

The assumption of constancy of fertility and mortality poses a serious challenge to mortality estimation in situations of declining fertility or mortality. In this paper, we propose to apply a Brass related procedure suggested by Preston and Palloni (1978), which avoids the assumption of constant fertility, to estimate infant and child mortality levels in Zambia using the 1990 census data. This method, which depends on the own-child procedure used in fertility estimation, provides more robust estimates of mortality in situations of declining fertility (Preston and Palloni, 1978; Preston and Haines, 1984; United Nations, 1983). An "own-child" is one who is identified as the natural offspring of the mother through an examination of the relationship of the child to both the head of household and the mother in the census micro-data.

Given the fertility transition now under way in a number of African countries, it is important that we begin exploring methods of mortality and fertility estimation that take into consideration this transition. Results from this procedure are compared with those obtained by the Zambia Statistical Office using the traditional method from the same data and also estimates from the 1992 Zambia Demographic and Health Survey (ZDHS).

The Own-Child Procedure

The own-child method, also referred to as the "surviving-children" method, is based on information on ages of surviving children recorded in censuses or surveys. In censuses/surveys where data are collected on ages of children and mothers within households, it is possible to link the records of mothers with their own children to create partial birth histories. Zuberi and Sibanda (2000) have linked the data for the Zambian census of 1990. Once children have been linked to their mothers in households, it is possible to tabulate children according to their own ages and also by the ages of mothers. With this information, it is possible to back-project the surviving children by age of mother to estimate the number of children ever born. This information is subsequently used to compute the mean ages of surviving children by mother's age, and the proportion of surviving children to reporting women, which is used to estimate mortality (Preston and Palloni, 1978). The general form of the estimation equation for this method is:

$$\frac{B}{B - D} = \int_0^{\alpha} \frac{c_s(a)}{1 - q(a)} da \quad ,....(3)$$

where *B*, *D and q(a)* are as defined in equation 2, and $c_s(a)$ refers to the proportion of surviving children to reporting mothers who are now age *a.* The potential advantage of using equation 3 instead of equation 2 to estimate mortality is that equation 2 has two unknowns – *q(a)* and *c(a)*, while equation 3 has only one unknown *q(a)*. This is because $c_s(a)$ in equation 3 can be estimated directly from the census once there is information on births, survivors, and ages of surviving children and their mothers. In other words, the main advantage of this procedure is that mortality from Brass-type estimates can be accurately made without relying on assumptions that are violable (Preston and Palloni, 1978; Preston and Haines, 1984, 1991).

The own-child method has several other explicit advantages over the more conventional indirect methods. The major advantage of incorporating the ages of surviving children is that it provides a more precise indication of the fertility history of reporting women than the Brass procedures. Unlike the conventional Brass approach, the surviving-children approach is insensitive to declining fertility or irregular patterns of fertility that might have occurred in the past. Whatever fertility pattern prevailed in the past will be reflected in the age distribution of the surviving children; i.e. the age distribution of surviving children is used to define the age distribution of children ever born without recourse to fertility models (Preston and Palloni, 1978; United Nations, 1983; Preston and Haines, 1984, 1991).

Also, the method is more flexible both in terms of age groupings and by marital duration. An additional advantage of the surviving-children approach is that it can be used for estimating infant and child mortality among social groups defined by characteristics such as marital status, rural-urban residence, occupation, or ethnicity. Although the own-child procedure was developed in the late 1970s, it has rarely been applied to African census data. Preston and Haines applied the method to estimate infant and child mortality in the United States using the 1900 census in *Fatal Years*, published in 1991.

While acknowledging the advantages of the own-child method, it must be noted that the method has its own problems: it is sensitive to age-selective omissions and mis-reporting of ages of children. Secondly, since the method requires linking children in households to their mothers, a high proportion of the children must be linked to mothers. The estimate of unlinked children was corrected using adjustment factors estimated from the data on linked children. The adjustment factors were calculated as a reciprocal of the proportion of linked children aged x to x+1 at the time of the census (Cho et al., 1970; Cho et. al., 1986; Zuberi and Sibanda, 2000).

The adjustment factors for the Zambia data are comparable to those derived by Cho and colleagues (1970) (1986). Three forms of bias are associated with linkage levels: (1) mismatch, (2) misallocation, and (3) missing of children. Mismatch errors are typically associated with overmatching of children to women that are not the biological mother. This type of error typically occurs when the linking algorithm lacks precision in the codes for the relation to the head of household. As with fertility, this type of error is important in the distortion of some age-specific rates, but will tend to affect the mortality rates very little (Cho et. al., 1986; Zuberi and Sibanda 2000).

The second type of linking error is associated with the misallocation of unlinked children. This type of error is expected in cases were there are high rates of fosterage and adoption is a culturally acceptable practice. We have assumed that unlinked children are distributed by age of mother in the same way as own children of the same age. This assumption may introduce some bias, because the unlinked children from younger mothers may be reallocated to older mothers. As a consequence, the estimated age pattern of mortality may be too high at the younger reproductive ages and too low at the higher reproductive ages.

Finally, missing children bias own-child estimates because some children may reside in a geographic area other than the study area in which the mother lives. This is a problem if we have large-scale in-migration and women leave children temporarily in the care of relatives at the point of origin until they resettle. In this situation the own-child estimates of mortality in the destination area are upwardly biased. We expect that bias from this source is probably very small in Zambia, because migrants who are separated from their young children would constitute a very small proportion of the female population.

For these and other reasons, Preston and Palloni (1978) recommended that analysis of childhood mortality based on the own-child method be restricted to younger women (15–34), since children of these women would mostly be young and likely to still be living with their parents in the same household.

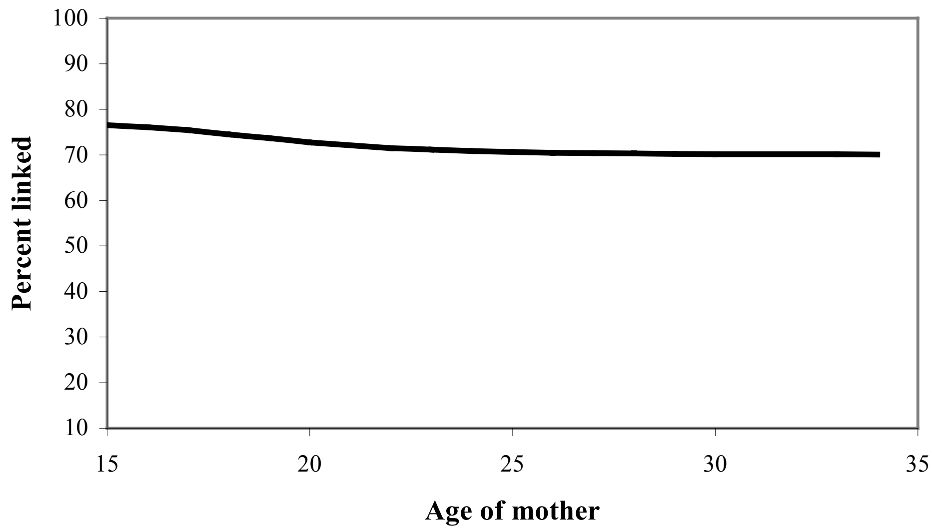
Our purpose is to demonstrate the applicability of the own-child procedure to African census data. We apply the method to estimate levels and trends using the 1990 Zambia census data. Census data offer many advantages for demographic analysis. First, census data provide total population counts, which allow us to circumvent problems of both sample size and non-representativeness. Second, because censuses cover whole countries it is possible to do analysis at various levels and by population subgroups; the own-child method allows such estimation. Third, own-child methods are appropriate for multivariate analysis. Results are compared with estimates derived from other procedures commonly used in Africa.

Data

The data for this paper are from the 1990 Zambia national census. The census, conducted in August 1990, was a total count of the whole population of Zambia with 3,617,577 males, and 3,765,520 females, yielding a total population of 7,383,097. The population of women within the reproductive age group is 1,988,427, with a total of 4,184,054 reported surviving children. For purposes of this paper however, we have restricted our analysis to women between the ages of 15 – 34 because of the problem of children of older women not likely to be leaving in the same households with their mothers. As already noted the surviving-children procedure utilises in addition to reports of the number of children ever born and the number dead or surviving, the ages of surviving children as reported in the household records. This information is provided in the household listings, where all members of each household are listed, including information on their ages and their relationship to the head of the household. Information on the number of children ever born, number of those children still surviving and/or dead was collected for all women 12 years and above in the census. With information on children and women in each household, as well as the relationship codes, Zuberi and Sibanda (2000) have been able to link surviving children in each household to their mothers. This information has been used in this paper to reconstruct partial birth histories of women and utilised for the estimation of infant and child mortality.

In linking children to mothers, age at first birth and current age of women are used as the lower and upper limits in the assignment process. For each woman, the relationship code and the potential child are checked to see if these dates and ages are compatible. Each child's age is also checked to see if it fits within the woman's reproductive window. Finally, the number of children still residing with her is checked against the total number and sex of children enumerated. For each resident woman, information on the number of children ever born and currently co-residing with their mother is checked against those children listed under her. The linking of children stops when the number of children linked to a woman reaches the number of living children she reports. This step is repeated for additional resident women in the household. Women or children with missing ages were dropped. Below is a graph showing the percentage of children linked to women between the ages of 15–34 mothers by age of children. We have restricted this to children 15 years and below.

Figure 1: Percentage of children ages 0 - 5 years linked to women 15 - 34



As expected, greater links were achieved for younger children (0-5) of younger women (15-34) in the households. This is not surprising because we expect younger women to reside in the same household with their kids because these children would on average still be too young to live elsewhere without their parents. On the other hand, children of older women are more likely to reside elsewhere without their parents because on average they are likely to be older compared to those of the young mothers. Overall, about 71 percent of children of women within the ages of 15 and 34 were successfully linked to their mothers. However, for women in the 15-19 years age group, the percent linked is about 77 and 70 percent for those within the age group 30-34. The comparatively lower percentage of linkage for the older women may be the result of some of their children probably residing elsewhere and attending school or in the care of other relatives (McDaniel and Zulu, 1996).

Assessment of Data

A major problem with retrospective data is the quality of the information. One of the major sources of bias is either underreporting or over-reporting of events – births and deaths. For instance, if stillbirths are recorded as live births, this can bias the estimates since births will be overestimated. A second source of bias results from underreporting of neonatal deaths. In many cultures in sub-Saharan Africa, when a child dies shortly after birth such a child is often not regarded as part of the family and when reporting on children ever born to the family, parents often do not include such children (Republic of Kenya, 1994). The exclusion of such children in censuses may bias estimates of infant and child deaths downward. Another source of bias is mis-reporting of dates of births and deaths, which is common in societies where literacy rates are low.

In view of these possible problems, we assessed the data to check its quality. Simple procedures exist for checking the consistency of data. One such procedure is to compute and examine the general or age-specific sex ratios. The general expectation is that these should approximate the overall sex ratio. According to the United Nations (1992), the general sex ratio for sub-Saharan Africa is 99 males per 100 females. Any systematic deviation from this pattern is indicative of selective omission of either male or female children. Zambian sex ratios in the census data are consistent with the general pattern observed in sub-Saharan Africa (see Table 1). A second measure used to assess the quality of the data is an examination of the mean number of children by age of women. In general, these should increase systematically with age of women. Again, this check does not reveal any serious data problems. The mean number of children increased progressively with the age of women. Table 1 also presents number of women and children and their corresponding mean numbers of children born by sex of child.

Table 1: Mean number of children ever born and sex ratios, Zambia 1990

Age Group	Women	Children Male	Children Female	Mean Number of Children per Woman Male	Female	Both	Sex Ratio
15-19	549586	51289	51584	0.1	0.1	0.2	0.99
20-24	434752	245704	246339	0.6	0.6	1.1	1.00
25-29	321493	409997	409418	1.3	1.3	2.5	1.00
30-34	243811	508390	507368	2.1	2.1	4.2	1.00
35-39	166549	450642	446938	2.7	2.7	5.4	1.01
40-44	152405	488457	484690	3.2	3.2	6.4	1.01
45-49	119831	398141	393799	3.3	3.3	6.6	1.01

Source: 1990 Zambia Census micro-data

Applying the "Own-Child" Method for Estimating Mortality in Zambia

Researchers often assume three different mortality scenarios/conditions.

i). Mortality pattern known, but no mortality trend suspected.

ii). Mortality pattern postulated, but there is no trend suspected. It is rare to be absolutely certain that a particular mortality pattern pertains, although there might be a priori reasons to prefer one model to another, and

iii). Mortality trends are suspected.

In this paper, we adopted the first assumption because available literature indicates that the pattern of mortality in Zambia is best described by the "North Model" pattern of the Coale and Demeny life tables (Central Statistical Office, 1990; Hill, 1991;

Hill, 1983). The analyses in this paper are therefore based on the "North Model." For the purposes of comparison however, we also estimated the mortality indices using the East, South and West models (see Appendix I).

Modifying the Sullivan (1972) and Trussell (1975) regression equations that relate the ratio of *q(a)/D/B* to variables representing the age or marital duration of averaging sequence, Preston and Palloni (1978) related this ratio to indices of the age structure of surviving children:

$$\frac{q(i)}{D/B} = \alpha_{(i)} + \beta_{(i)} As + \sigma_{(i)} C(2), \ldots .(4)$$

where ***i*** refers to age group of mother; ***q(i)*** refers probability that a child born i years ago has died; ***D/B*** refers to ratio of dead children to those ever born by age group of reporting women; A_s refers to mean age at last birthday of surviving children born to reporting women; and ***C(2)*** refers to the proportion of surviving children of reporting women who are now ages 0, 1 or 2 at last birthday.

By using the age structure of surviving children, i.e., the mean age at last birthday, A_s, and the proportion of all children below age 3, ***C(2)***, this procedure is expected to yield more plausible results. The A_s seeks to identify the mean duration of exposure of children to mortality, and the ***C(2)*** distinguishes between children in their early years when the risks of mortality risks are highest, and those who have passed that stage. Furthermore, use of age structure of surviving children is easy to operationalize once children have been linked to their mothers and the indices of the age structure are computed.

In the census, *D* and *B* are easily obtained directly. However, A_s and ***C(2)***are estimated from the age distribution of surviving children enumerated with their mothers in the census (see Appendix II).. The coefficients, ***α, β*** and ***σ*** are constants. With the computed A_s and ***C(2)*** values, coupled with the ***B*** and ***D***, equation 4 is used to estimate the ***q(i)*** for the respective age groups, the required and only unknown parameter in the model.

The estimated probabilities of dying before ages 1, 2, 3 and 5 (i.e., the q(i) values) and the corresponding mortality levels and life expectancies at birth are presented in Tables 2 and 3 below.

Table 2: Probabilities of dying before ages 1, 2, 3 and 5 for Zambia, 1990 census

		Probabilities of Dying, $q_{(x)}$				
Age	Age	Male		Female		Both
Group	x	Own-Child	Brass	Own-Child	Brass	Sexes*
15-19	1	0.146	0.140	0.137	0.138	0.141
20-24	2	0.156	0.165	0.144	0.152	0.150
25-29	3	0.160	0.165	0.144	0.149	0.152
30-34	5	0.165	0.169	0.151	0.155	0.158

Source: Brass estimates are from the 1990 Zambia Census Analytical Report, 1990 and own-child estimates are based on Zambian Census micro-data. Estimates for both sexes are own-child estimates

Table 3: Time reference and expectations of life corresponding to mortality levels

Age Group	Time References					Expectation of Life		
	Males		Females		Both			Both
	Own-Child	Brass	Own-Child	Brass	Sexes	Males	Females	Sexes
15-19	1989.6	1988.6	1989.6	1988.6	1989.6	42.8	43.3	43.4
20-24	1988.4	1987.3	1988.4	1987.3	1988.4	46.7	47.2	47.9
25-29	1986.7	1985.5	1986.6	1985.5	1986.6	51.3	51.0	50.3
30-34	1984.3	1983.4	1984.3	1983.4	1984.3	50.9	53.3	52.2

Source: Same as Table 2

Overall estimated probabilities of dying before age 1, q(1), for Zambia around 1990 were estimated to be 0.141 for both sexes, 0.146 for males and 0.137 for females. The corresponding estimates for females and males computed by the Zambian Central Statistics office based on the Trussell variant of the Brass methods are 0.140 and 0.138, respectively. Similarly, the probabilities of dying before age 5, ${}_5q_0$, are 0.165 for males and 0.151 for females. The corresponding estimates by the census office are 0.169 and 0.155, respectively. The results show that males have higher mortality than females as portrayed by the *q(a)* values. This finding is consistent with evidence suggesting a male mortality disadvantage (Makinson, 1994; Waldron, 1996).

Although based entirely on different procedures, the estimates are very similar. Estimates from the Zambia census report are based on the Brass method, computed using the United Nations mortality measurement package known as "Mortpak-Lite." In general however, estimates by the census office are slightly higher than our estimates using the own-child approach, but the differences are very small. The estimates compare closely as is clearly in seen in figures 2 and 3.

Figure 2: Comparison of mortality levels by method - Females

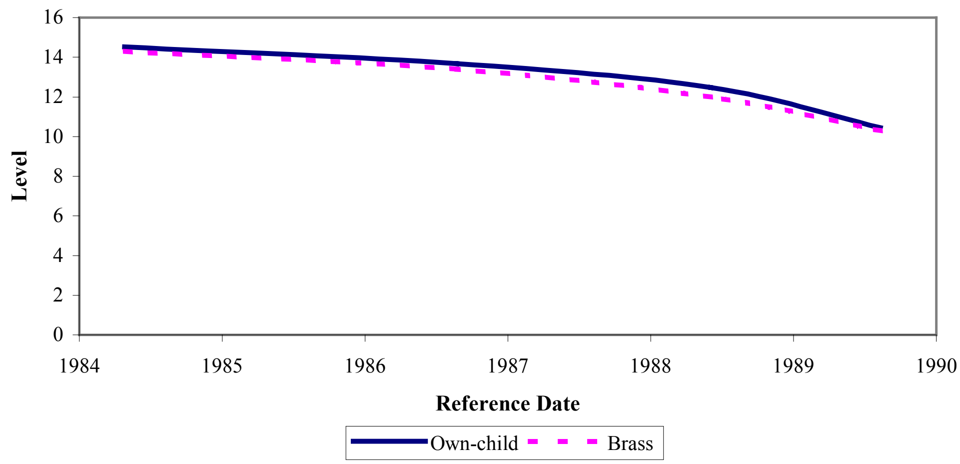
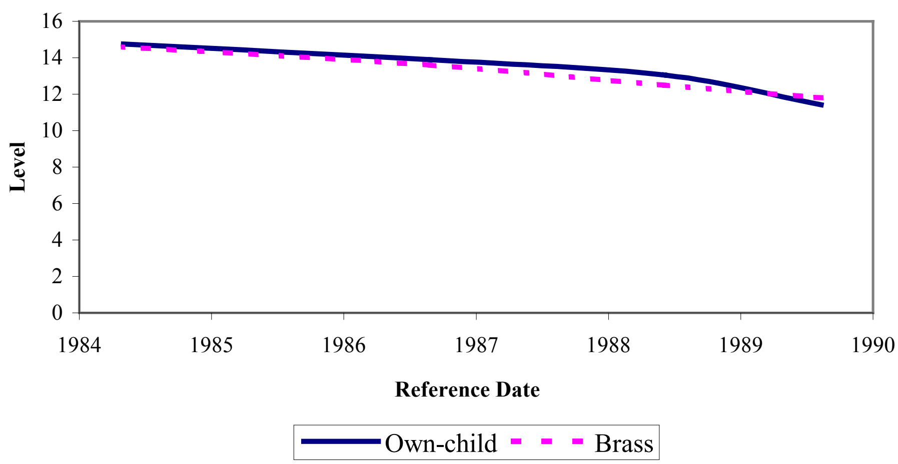


Figure 3: Comparison of mortality levels by method - Males



Unlike the Brass method however, the own-child method is able to actually map out the fertility history of the women and, therefore, to provide more information about how long ago children were born, allowing for potentially greater precision in estimating mortality (Preston and Palloni, 1978). We would also expect the own-child method to potentially provide better estimates if fertility had declined drastically in Zambia. The close comparability of the results imply, however, that in general there will not be much difference in the estimates between the two methods if fertility has not changed much in the recent past.

The real potential of the own-child procedure though, is that the analyst does not have to make assumptions about the state of fertility in the recent past. Close comparability of the estimates also suggests that age mis-reporting is not a serious problem in the census, providing a sound basis for application of the own-child procedure for analysis by subgroups within the population (by education, marital status, ethnicity, etc.) -the real strength of the method.

The results indicate that infant and child mortality levels have been rising in Zambia since the early 1980s. The patterns of mortality shown by the two approaches are basically the same, as shown by the figures. The mortality levels corresponding to the q(x) values (Table 2) show that infant and child mortality levels have been rising in Zambia since the early 1980s.

While censuses or surveys are usually taken at particular points in time, events recorded at the census or survey would have occurred some time in the past prior to the actual date of the census. To situate the estimates in the actual time period when such mortality would have occurred, the reference dates have been estimated (shown in Table 3), using the computational formula below.

$$t = \alpha_i + b_i PAR1 + c_i PAR2 + e_i, \ldots .(5)$$

Where ***α, β*** and ***σ*** constants; ***PAR1*** refers to parity 1; ***PAR2*** is parity 2; and ***e*** is an error term built in to the equation (see Table 7 of Preston and Palloni, 1978). The estimates date as far back as 1984

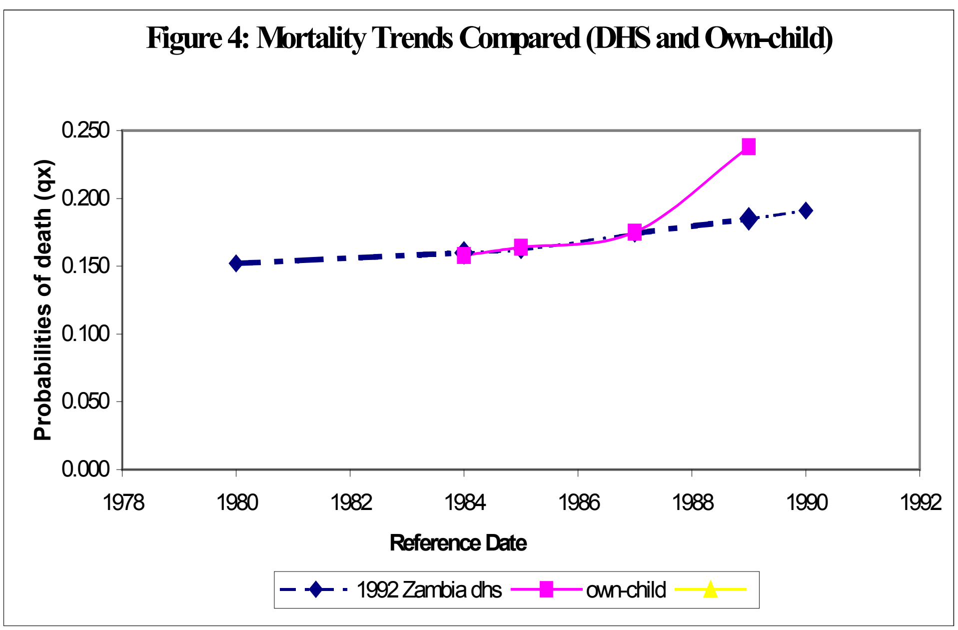
To analyse trends and facilitate easy comparisons both within and between different data sets, it is possible to convert the estimated q(x) values corresponding to ages 1, 2, 3 and 5, to a “Common Index” (United Nations, 1990). To compare our estimates from the own-child method with those of the 1992 Zambia Demographic and Health Survey (ZDHS), we converted the own-child estimates to an index similar to the one used in the DHS estimates. While the DHS estimates for q(1) and q(5) are based on all women 15-49 years of age, the corresponding estimates from the own-child method are based on women 15-19 for q(1), and 30-34 for q(5).

Although any index from the selected model life table can be used, it is preferable to use a measure of child mortality that is not sensitive to the pattern of mortality. The measure recommended by the United Nations is q(5). We used the levels of mortality implied in the United Nations’ “North” model life tables corresponding to q(1), q(2), and q(3) computed from the 1990 Zambian data using the own-child procedure as entry parameters, to estimate the corresponding q(5) values from the life table using a simple linear interpolation procedure:

$$q^{c} = \left(\frac{x - x2}{x1 - x2}\right)q1 + \left(\frac{x - x1}{x2 - x1}\right)q2, \ldots (6)$$

where q^c refers to the ***q(5)*** value corresponding to level of mortality at age ***x; x*** refers to the level of mortality in the life table corresponding to each of ***q(1)***, ***q(2)*** and ***q(3); x1*** & **x2** refer to the level of mortality just below and above level ***x*** in the life table family; and ***q(1)*** and ***q(2)*** refer to the ***q(5)*** values associated with each of ***x1*** and ***x2.***

The computed *q(5)* values are compared directly with the 1992 Zambia DHS estimates for *q(5)*. We have dated the DHS estimates to facilitate comparison with the estimates we computed from the census data. These are plotted:



It is evident from figure 4 that both the estimates from the Zambia DHS and our own-child estimates show a common trend – under-five mortality has been rising in Zambia since the early 1980s. This finding is consistent with those emerging from other sub-Saharan African countries that show an upward turn of infant and child mortality, as noted earlier. What is particularly striking about the graph though, is the consistency of the results. Except the estimate for the 15-19 year group in the census, which is very high, the rest of the estimates compare closely with the DHS estimates. The high mortality pattern indicated by children of women aged 15-19 has been observed in other settings. As Preston and Haines (1991) pointed out in the *Fatal Years,* "…estimates for this age group are often erratic." They explained that the unusually high mortality observed among children of women in the age group 15-19 years could either indicate bad data or, more plausibly, result from a disproportionately higher number of first births or births to younger women known to be prone to higher risk.

Discussion and Conclusion

This paper estimated levels and trends in infant and child mortality from the 1990 Zambian census data using the own-child procedure proposed by Preston and Palloni (1978), a method that has scarcely been employed in analysis of mortality in Africa despite its obvious advantages over the traditional Brass method. We believe that part of the reason for its unpopularity in mortality estimation, especially for Africa, is its data requirements and the fact that it requires a lot of data manipulation before it can be applied. Applying the own-child procedure not only requires accurate reporting of ages, but also requires data on birth histories of women. If the survey or census does not collect information on birth histories, the analysis requires a construction of “partial” birth histories from information on the ages of mothers and their surviving children reported in the census through linkage procedures from information on relationships in households. This involves rigorous computational procedures and time.

However, with the current computer technology and software, it is now possible to reconstruct partial birth histories from information on ages of surviving children and mothers reported in censuses through linkage procedures. The own-child approach avoids the use of synthetic cohort comparisons using average parity ratios. The fertility history of women is inferred from the age distribution of children, which should give better estimates since results from this procedure are not biased by fertility trends. Secondly, in applying the own-child procedure, the analyst does not have to assume that fertility has remained constant in the past, an assumption that is violable especially in the current African circumstances.

Results from the own-child procedure closely compare with those obtained using the traditional Brass method. This is not surprising since fertility has not declined in any appreciable way in Zambia in the recent past. Nonetheless, the results also show that it is possible to estimate mortality accurately without having to make the assumption of constancy in the levels of fertility. However, it is important to note that in situations of considerable fertility decline, the own-child procedure may provide different and potentially better estimates.

Our results indicate that infant and child mortality rates have been rising in Zambia since the early-to-mid-1980s. The factors accounting for this recent upward turn in mortality are not yet clear, although there is speculation that this is a result of the increasing rates of HIV/AIDS infection, and /or increasing deterioration in socio-economic conditions. The need for more research to unravel the causes is needed. The next step is to use these methods to understand the spatial and socio-economic determinants of mortality differentials in Africa and own-child estimates may prove useful in this effort.

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Appendix I

Both Sexes

Age Group	Index X	North	South	East	West
		Probabilities of dying before age x			
15-19	1	0.141	0.136	0.146	0.145
20-24	2	0.150	0.155	0.160	0.148
25-29	3	0.152	0.162	0.162	0.160
30-34	5	0.158	0.164	0.162	0.162

Males

Age Group	Index X	North	South	East	West
		Probabilities of dying before age x			
15-19	1	0.146	0.141	0.151	0.150
20-24	2	0.156	0.161	0.166	0.155
25-29	3	0.160	0.170	0.170	0.169
30-34	5	0.165	0.171	0.169	0.169

Females

Age Group	Index X	North	South	East	West
		Probabilities of dying before age x			
15-19	1	0.137	0.132	0.141	0.140
20-24	2	0.144	0.148	0.153	0.142
25-29	3	0.144	0.154	0.153	0.152
30-34	5	0.151	0.156	0.155	0.155

Appendix II

A matrix showing number of children by age group of women and C(2) and A_s values for both sexes and by sex

Both sexes — Ages of child

Age of woman	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			C(2)	As
15-19	25826	13422	7005	3317	1284	323	0	0	0	0	0	0	0	0	0	51177	46253	0.90	0.9
20-24	59482	48323	43058	36420	27935	19091	12500	0	0	0	0	0	0	0	0	246809	150863	0.61	2.1
25-29	49993	46056	46933	47408	49379	44368	42558	37490	33986	25052	20426	11889	0	0	0	455538	142982	0.31	4.5
30-34	35940	34284	36420	37869	42138	39105	42270	40169	43604	39012	42098	33399	34348	27300	24245	570100	106644	0.19	7.0

Males

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			C(2)	As
15-19	12864	13422	3467	1605	621	161	0	0	0	0	0	0	0	0	0	32140	29753	0.93	0.9
20-24	29509	24113	21409	18203	13920	9465	6096	3323	1920	680	315	0	0	0	0	128953	75031	0.58	2.4
25-29	25070	23236	23143	23512	24637	22303	21359	18770	16659	12250	10009	5872	3911	1972	905	233608	71449	0.31	4.7
30-34	17929	17326	18030	19038	21010	19664	21177	20162	21461	19379	21166	16664	17109	13543	11995	275653	53285	0.19	6.7

Females

Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			C(2)	As
15-19	12962	6800	3538	1712	663	162	0	0	0	0	0	0	0	0	0	25837	23300	0.90	0.9
20-24	29971	24209	21645	18215	14015	9621	6404	3567	2037	750	332	0	0	0	0	130766	75825	0.58	2.4
25-29	24920	22820	23786	23892	24738	22065	21359	18716	17326	12801	10415	6017	3985	1931	962	235733	71526	0.30	4.8
30-34	18010	16957	18390	18829	21127	19664	21177	20003	22143	19631	20930	16734	17234	13756	12250	276835	53357	0.19	6.7

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