The Demography of Zimbabwe: Some Research Findings

University of Zimbabwe Demographic Unit

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Introduction

Mortality is an important component of population change. Its decline in the Third World during the second half of the present century has played a significant role in accelerating the rate of population growth. Although the fertility level of a country is expected to be a more decisive factor in determining future population growth rates, mortality levels are considered to be sensitive indicators of the level of development of societies and communities. Infant and child mortality rates are important indicators of health in countries lacking information on adult mortality conditions (the majority of developing countries). These rates function as important indicators of mortality of all age groups (Preston, 1985).

Beyond their usefulness as health indicators, infant and child mortality rates are an essential part of demographic accounting. The birth rates and growth rates of a population cannot be known with any certainty without accurate infant and child mortality rates. All of these rates are required for an adequate understanding of demographic phenomena (CSO, 1985). Infant mortality in particular has been considered an important indicator for describing mortality conditions, health progress and, indeed, the overall social and economic well-being of a developing country (United Nations (UN), 1988; CSO, 1985). It has become increasingly clear that child mortality needs to be examined in addition to infant mortality for the following reasons:

- Child mortality is still high in many countries, particularly in less-developed regions, where a substantial proportion of deaths occur between one and five years of age (UN, 1988).
- The proportion of child deaths, under and over age one, vary considerably so that infant mortality levels may not correctly estimate the level of early age mortality.
- The causes of death at ages one to five years are significantly different from those in infancy, so that programmes for reducing infant mortality may not be the same as those for reducing child mortality (UN, 1988; UN, 1983).

About 15 million children under the age of five are estimated to have died annually from 1980–1985. This represents 30% of all annual deaths in the world

(UN, 1988). The majority of these child deaths occurred in developing countries and a large proportion of them are believed to have been preventable. Young child mortality may therefore be considered one of the greatest health problems in the world.

Adult mortality estimates combined with infant and child mortality estimates give a clear picture of the mortality conditions of a given population. Female adult mortality levels to some extent affect the trends of infant and child mortality, hence their inclusion in this study. Maternal complications, a major cause of death among women of reproductive age in most of the developing world, has been given priority in all regional strategies for "Health for all by the year 2000" (World Health Organization (WHO), 1986; Graham et al., 1989).

Official statistics from civil registrations do not clearly highlight the problem of maternal mortality. In areas where the problem is at its greatest, most maternal deaths go unregistered, either entirely so or their cause is not specified. The poor registration of maternal deaths causes the gravity of the problem to be underestimated. The difficulty of measuring maternal mortality has long proved an impediment to alerting health planners of the magnitude and causes of this problem, which has in turn impeded effective intervention (Graham et al., 1989; WHO, 1986).

Aims

This study aims to make use of the Chitungwiza Socio-Demographic Survey (University of Zimbabwe, 1990) to produce:

- estimates of infant and child mortality (A)
- estimates of female and male adult mortality using the "orphanhood" method (B)
- an estimate of maternal mortality using the "sisterhood" method
- "relational life tables" using survival probabilities generated from (A) and (B) above.

Methods

The indirect methods for estimating infant, child, adult and maternal mortality rates, which will be discussed and used in this study are those developed by Brass (1975), Brass and Hill (1973) and Graham et al. (1989) respectively. The Trussell (1975) and Sullivan (1972) methods will also be used to estimate infant and child mortality. The Sullivan (1972) and Trussell (1975) models attempt to increase the flexibility of Brass's original method. Sullivan (1972) computed another set of multipliers by using least square regression to fit Brass's estimation equation $qx = Ki*Di$. Ki is the multiplier used to adjust for non-mortality factors determining Di, the proportion of dead children ever born to women in successive five-year age groups, and qx is the probability of dying between birth and exact age x, for data generated from observed fertility schedules and the Coale and Demeny life tables (UN, 1983; Sullivan, 1972). Trussell (1975) produced a third set of multipliers by the same means but using data generated from the model of fertility schedules developed by Coale and Trussell (1974). The general theory on which the Sullivan and Trussell methods are based is essentially the same, but the use of a different data base results in considerably different multipliers (UN, 1983).

The data from Chitungwiza shows that reliable estimates of infant, child, adult and maternal mortality can only be obtained through the use of indirect methods. The indirect methods rely on data which is easy to obtain through any type of survey or census. The results obtained from these methods are easy to compare with results from independent sources leading to the robustness of the methods and the production of accurate results. However, the estimates derived using these techniques should be taken at face value.

Sullivan's and Trussell's models are modifications of the original Brass method, and so the differences in qx arises from the use of different sets of multipliers. The three indirect methods require the same type of data to arrive at infant and child mortality estimates.

- The number of children ever born, classified by five-year age groups of mother. If the data is not available by gender, both genders can be grouped in one category.
- The number of children surviving (or the number of children dead) classified by gender and by five-year age groups of mother.
- The total number of women (irrespective of marital status) classified by five-year age groups (Sivamurthy et al., 1980; UN, 1983).

Estimation of infant and child mortality levels based on duration of marriage is not attempted in this study for the following reasons:

- The use of data classified by marriage duration is not recommended in countries such as Zimbabwe where consensual unions are frequent and relatively unstable.
- The duration of marriage is more likely to be erroneously reported than the age of women (CSO, 1985).

The data needed in the Brass and Hill (1973) orphanhood method for estimating adult mortality is as follows:

- Number of respondents with mother (father) alive (or dead) classified by five-year age groups from n to n+5. This proportion is denoted by 5P(N). The set of proportions 5P(N) can be calculated when any of the two following items are available:

- number of respondents with mother (father) alive
- number of respondents with mother (father) dead
- total number of respondents whose mother's (father's) survival status is known.

It is important to exclude from the calculations all respondents who did not know or did not declare their mother's (father's) survival status.

- Number of births in a given year classified by five-year age groups of mother (father).

This information is needed to estimate M, the mean age of mothers (fathers) at birth of their children in the population to be studied. The M to be estimated is not the mean age of fertility schedule (also known as "mean age of child-bearing") but the mean age of fertility schedule weighted by the distribution of the female (male) population. It may be regarded as an estimate of the average age difference between mother (father) and child in the population, thus being an indicator of the average age at which the target persons (parents) begin their exposure to the risk of dying (UN, 1983; Brass and Hill, 1973).

The estimates of maternal mortality are derived using the sisterhood method devised by Graham et al. (1989). This method is a new, indirect technique for deriving population-based estimates of maternal mortality. The method uses the proportions of adult sisters dying during pregnancy, childbirth or the puerperium (the first six weeks after pregnancy) reported by adults during a survey, to derive a variety of indicators of maternal mortality. The data required for estimating maternal mortality is as follows:

- The number of adult sisters dying during pregnancy, childbirth or puerperium reported by adults and classified by age group of respondents. This will be added to give total maternal death reported per five-year age group.
- The number of ever-married sisters classified in five-year age groups.
- The number of respondents in each five-year age group.

Assumptions

The following assumptions are needed for the models to yield accurate estimates.

Infant and child mortality

- Age-specific fertility rates and infant and childhood mortality rates have been approximately constant in recent years.
- No strong association exists between age of mother and infant mortality, or between death rates of mothers and their children.

- Omission rates of dead children and surviving children are about the same.
- The age pattern of mortality among infants and children conforms approximately to the model life tables (UN, 1967).

Adult mortality

- Population is stable, meaning that fertility and mortality have been constant.
- Mortality of parents is independent of the number of children born to them.

The Brass model

The multipliers (Ki) developed by Brass (1975) enable the conversion of the proportion of dead children among those ever born reported by women in the age intervals 15–19 years to 44–49 years, into estimates of the probability of dying before reaching certain childhood ages (qx). The relationship between Di and Ki represented by Ki depends upon the age pattern of fertility and the age pattern of mortality in the area of study. The age pattern of fertility determines the distribution of children by duration of exposure to risk of dying. In general, the earlier the commencement of child-bearing, the older the children in each maternal age group; these children have therefore been exposed longer to the risk of dying than children of women of the same age in a late child-bearing population. It is therefore important that the fertility pattern be taken into account in converting Di into corresponding qx values. The current distribution of average parities by age group of women is used as an indicator of the shape of lifetime. The ratio of the average parities of women aged 15–19 to those aged 20–24, P1/P2, and that of women aged 20–24 to those aged 25–29, P2/P3, and the m, the mean age of child-bearing, are the key determinants in the selection of multipliers. The greater the P1/P2, the earlier the pattern of child-bearing, hence the greater the child's exposure to mortality forces. In addition to the pattern of fertility, the pattern of mortality is also considered in determining Ki (to convert Di into qx). The age pattern of mortality is represented by different model life tables. The basic converting equation is $qx = Ki*Di$ where Ki is the multiplier factor meant to adjust for non-mortality factors determining the value of Di.

The Sullivan model

Sullivan's model based on age is a modification of the original Brass (1968) method which used algebraic functions to simulate the relationship between Di and qx. Sullivan developed multipliers using regression equations. In the regression model the ratios of selected pairs of qx and Di (qx/Di ratios) for fixed values of x and i are related to a fertility schedule parameter. Three types of data are needed in order to use the regression analysis. These are:

- the probability of dying between birth and various age $q(x)$ values
- fertility schedule parameters
- the proportions dead of children ever born (CEB) to women in five-year age intervals (Di).

Sullivan used a set of 65 fertility and 40 mortality schedules to generate the data needed. The qx/Di ratios for which the regression analysis was most successful were found to be the q2/D2, q3/D3 and q5/D4 ratios. In the 12 data sets used in the analysis, the fertility parameter which was found to best explain variations in the value of the qx/Di ratios was the P2/P3 correlates rather than the P1/P2 (the Brass parameter). It is for this reason that P2/P3 was used as the explanatory variable in the model which was specified as:

$$qx/Di = Ai + Bi(P2/P3)$$

where the values Ai and Bi are given for each of the four families of the Coale and Demeny model life tables (Coale and Demeny, 1983).

The Trussell model

Trussell (1975) noted that Sullivan was limited to the few empirical fertility schedules which had been gathered by the Princeton Office of Population Research over the years in which early fertility schedules were severely underrepresented. Sullivan (1972) had tried to overcome the problem by sliding empirical schedules down the age axis. A study undertaken by Coale and Trussell (1974) for the Princeton Office noted that the age pattern of fertility is different when age at fertility commencement is early rather than late. Therefore, sliding fertility schedules along the age axis does not adequately replicate later or earlier patterns of fertility. As a result of this, Trussell (1975) decided to re-run the experimental test of the Brass model performed by Sullivan, using a number of empirical fertility schedules which can simulate early as well as late patterns of child-bearing.

Trussell (1975) varied the parameters of the fertility function and 1 568 different schedules were derived. Age at first marriage was allowed to vary from 12 to 18 years, thus enabling the inclusion of many schedules with early starts as well as late starts. To estimate Ki values Trussell used the formula:

$$Ki = A(P1/P2) + B(P2/P3) + C\log(P1/P2) + D\log(P2/P3) + E$$

He later modified the original logarithmic formula to:

$$Ki = ai + bi(P1/P2) + ci\,(P2/P3)$$

where ai, bi and ci are coefficients (UN, 1983).

The modified coefficients and version of the original Trussell formula are the ones to be adopted for use in this study because they are more recent and more satisfactory than those proposed by Trussell in 1975 (UN, 1988).

The Brass-Hill Orphanhood model

The Brass-Hill orphanhood technique (1973) converts proportions of respondents with living parents into a survivorship ratio and hence into life expectancy values. This technique uses a similar principle to that of estimating childhood mortality where the mothers are asked about the survival of the children in order to derive a relationship between the age of mother and the age of child and its probability of survival (Blacker, 1977). In the orphanhood method the same principle is applied: people are asked about the survival status of their parents. Adult mortality estimates may be based on children's reports of parental survival by gender of child or by both genders combined. In this study, adult mortality estimates are based on reports of offspring of both genders combined.

Brass and Hill (1973), using data on the proportions of respondents with living mothers, established an equation relating the female probability of surviving from age 25 to 25+N years, to the proportions of respondents in two adjacent five-year age groups whose mothers were alive at the time of the interview. Before proceeding with the formulation of the equation, Brass and Hill (1973) calculated M, the time period mean age of mothers at the birth of their children. M is the estimate of the age difference between mothers and children in the population and indicates the average age at the start of exposure to the risk of dying. M is dependent upon the age distribution of the female population, and is usually calculated from information on the births in the last year. M represents a mean age of the fertility distribution weighted by the female age distribution. Using the principles that link the proportions of surviving mothers of two adjacent age groups of respondents, Brass and Hill (1973) developed the following formulation:

$$l(25+N)/l(25) = W(N)*5P(N-5) + [\{1-W(N)\}*5P(N)] \quad (0.1)$$

In this context N is the central age of two consecutive age groups of respondents, so that 5P(N-5) is the proportion of respondents aged N-5 to N with surviving mothers, and 5P(N) refers to the age group N to N+5. W(N) are the multipliers tabulated by Brass and Hill (1973). The weights W(N) convert those not orphaned in adjacent age groups into life table survivorship probabilities from age 25 years to the central point of the two age groups. The weighting procedure also introduces some smoothing between consecutive proportions not orphaned. A set of multipliers is determined by M, the mean age at child-bearing and n, the central point of the age group being considered. The sets of weights W(N) are simulated by using a single mortality pattern (the African standard) and model fertility schedules with variable age locations and fixed shape (Brass and Hill, 1973; Economic Commission for Africa, 1979).

The form of the equation (0.1) above indicates that the probability of surviving from age 25 to age 25+N years is obtained by interpolation between the two proportions of surviving mothers. If both age groups were of equal weight then both W(N) and 1-W(N) would be equal to 0.5. The differing effects of fertility and mortality in adjacent age groups and the influence of M account for the variation.

The paternal orphanhood method of estimating male adult mortality follows the same principle as the maternal orphanhood method. People are asked about the survival status of their fathers and the proportions with fathers alive are translated into conditional estimates of male mortality. The paternal orphanhood method uses a formula very similar to that for maternal orphanhood:

l(B+N+2.5)/l(B) = W(N)*5PN-5 + [1-W(N)]*5PN (O.2),

where 5PN-5 is the proportion in the age group N-5 to N having surviving fathers; l(B+N+2.5) is the probability of surviving from age 32.5 to age 32.5+N+2.5; 5PN is the proportion in the age group N to N+5 having surviving father (UN, 1983).

Two tables with different base ages, B, are in use when calculating W(N). One gives weight, W(N), to calculate l(B+N+2.5)/l(B) for B = 32.5 and M is 28 to 36. In the other table B = 37.5 and M is 36 to 44. The choice of the weight tables depends upon the value of M (UN, 1983).

Calculation of M' for males has proved to be more difficult; while a mother must be alive at the time of her child's birth, the only known factor about the father is that he must have been alive when the child was conceived. Hence the father's exposure to the risk of dying is equal to the age of child plus nine months (UN, 1983).

While women's ages at the birth of children are fairly concentrated within a population, father's ages vary much more. The mean age of fatherhood at the birth of children, M', is expected to be high in societies practising polygamy. The assumption that all children were born when their mothers were aged M, the mean age of women at the birth of their children, is already a great simplification, but it is a much more demanding assumption to say that all fathers were the same age when their children were born. In monogamous societies, the mean age of mothers at the birth of their children (M), is taken and added to the difference d between the mean ages at first marriage for women and men to obtain M', the mean age of fathers at the birth of their children. Mean age of fathers is obtained using the following formula:

M' = M + d

where M' is the mean age of fathers at the birth of their children;

d = SMAMm - SMAMf

where SMAMm is the singulate mean age at marriage for males and SMAMf is the singulate mean age at marriage for females (Blacker and Mukiza, 1988).

In societies where polygamy is practised and where remarriage and marital breakdown have very different gender implications, estimating d by finding the difference between the SMAMs is not a satisfactory method. In cases of polygamous societies, d is estimated as the difference between the median of currently married men and women. The use of the median in the estimation of M' includes information on those in second and subsequent marriages. In this study, the mean age of fathers at the birth of their children is derived from the difference between the median of currently married women and men added to the mean age of women at the birth of their children (Blacker and Mukiza, 1988). In this study M' for males is equal to 31.74 thus the table with a B value of 32.5 was chosen in interpolation of W(N) to be used in equation O.2.

Sisterhood method

Graham et al. (1989) developed a simple procedure for deriving maternal mortality indicators based on the reported proportions of sisters who reached the age of exposure to the risk of pregnancy-related death and who are either alive or have died during pregnancy, child-bearing or the post-partum period. The sisterhood method can be viewed as an extension of the Hill and Trussell (1977) sibling survival technique. The key assumption of the sisterhood method is the independence of the mortality experiences of adult sisters (Trussell and Rodriguez, 1990).

In the sisterhood method, the proportion of sisters dying during pregnancy or childbirth, #(u), reported in a household sample survey by respondents aged u, may be related to the probability of dying from maternal causes by age u, q(u). The sisterhood method corrects the #(u) to provide an estimate of q(u) or of q(w), the probability of maternal death by the end of the reproductive period (lifetime risk).

Graham et al. (1989) suggest a method of applying adjusting factors Ai to the number of sisters entering the reproductive period, indicated by respondents in age group i (for five-year age group) to derive units of risk exposure to maternal death over the whole reproductive period Bi. Since the number of sisters who have entered the reproductive period, as reported by respondents in the younger groups, will exclude those sisters yet to enter the period, a raising factor is used to arrive at the expected ultimate number. Graham et al. (1989) suggest a method for adjusting these underestimates of ever-married sisters for the first two age groups by multiplying the number of respondents by the average number of ever-married sisters older than 25 years. Taking the number of maternal deaths, ri, and dividing by Bi, estimates were derived for adjusted sisters units of the risk exposure over the whole reproductive period, q(w).

Infant and child mortality

Although part of this study deals with infant and child mortality levels, only the levels for the age group 15–34 years are to be analyzed and discussed in this section. Estimates of 1q0 are to be treated with caution in the analysis of results because they are considered to be less reliable for several reasons. Firstly, children born to teenage mothers face relatively higher risks of death than children born to older mothers. As a result, the mortality experience of children born to women aged 15–19 years does not adequately represent that of children below the age of one year (UN, 1988). Secondly, reports by women aged 15–19 years are based on relatively small numbers and hence have high sampling variability. On the other hand, 10q0, 15q0 and 20q0 refer to mortality conditions in the distant past hence their omission in the description of child mortality in this study.

Estimates of infant and child mortality based on the three indirect methods are shown in Tables 7.1, 7.2 and 7.3. These three tables show some irregularities in the reported qx values as they decrease in certain cases with increasing ages of mother. This indicates of errors in reporting. In the absence of errors or of rising mortality, qx should increase with age of mother since they are the cumulative mortality experience of children from birth to certain exact ages. In order to derive the steady increase of mortality with age of mother (qx), Brass's logit system (1975) was used to smooth the values of qx. These results are also shown in Tables 7.1, 7.2 and 7.3.

The graduated 1q0 and the ungraduated 1q0 shown in Tables 7.1, 7.2 and 7.3 indicate relatively low infant mortality in Chitungwiza compared with the infant mortality levels reported by the 1987 Intercensal Demographic Survey or ICDS (CSO, 1991) and the Zimbabwe Demographic and Health Survey or ZDHS (CSO, 1989). The infant mortality levels 1q0 estimated in the ZDHS and the ICDS (53 and 40 deaths per 1 000 live births for urban areas, respectively) are somewhat higher than the infant mortality rates of 18 and 17 deaths per 1 000 live births estimated from the results of the 1990 Chitungwiza Socio-Demographic Survey or CSDS (University of Zimbabwe, 1990). See Tables 7.1 and 7.3 respectively.

As indicated in Table 7.1, out of every 1 000 live births, 36 children die before reaching the age of five. In comparison with the ZDHS (CSO, 1989) estimate of 55 deaths per 1 000 live births in Chitungwiza, this figure is relatively low. The child mortality rates, 5q0, estimated using the Sullivan and Trussell methods, were found to be the same (34 deaths per 1 000 live births). The child mortality estimates derived from these three indirect methods were found to be somewhat lower than the ZDHS (CSO, 1989) estimate (55 deaths per 1 000 live births for urban areas).

Table 7.1: Application of the logit transformation on infant and child mortality (both genders) estimates derived from Brass's weighting method: Chitungwiza, 1990

Age of child (years)	Estimated qx	1x	y(x) = logit lx	Standard Ysx	Yx-Ysx = (a)x	Smoothed Y(x)	qx
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	0.0743	0.9257	-1.2612	-0.9972	-0.2640	-1.9947	0.0182
2	0.0292	0.9708	-1.7520	-0.8053	-0.9467	-1.8029	0.0265
3	0.0254	0.9746	-1.8236	-0.7253	-1.0983	-1.7229	0.0309
5	0.0402	0.9607	-1.5995	-0.6514	-0.9481	-1.6492	0.0356
10	0.0376	0.9627	-1.6212	-0.5498	-1.0714	-1.5475	0.0433
15	0.0316	0.9684	-1.7112	-0.5131	-1.1981	-1.5108	0.0465
20	0.0180	0.9820	-1.9996	-0.4551	-1.5445	-1.4528	0.0519

m = 27.7 years

Table 7.2: Application of the logit transformation on child mortality (both genders) estimates derived from Sullivan's method: Chitungwiza, 1990

Age of child (years)	Estimated (qx)	1x of logit of 1x	yx	Standard Ysx	Yx-Ysx (a)x	Y(x)	Smoothed qx
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2	0.0287	0.9713	-1.7609	-0.8053	-0.9556	-1.8215	0.0255
3	0.0240	0.9760	-1.8527	-0.7253	-1.1274	-1.7415	0.0298
5	0.0379	0.9621	-1.6171	-0.6514	-0.9657	-1.6678	0.0344

m = 27.7 years

Table 7.3: Application of the logit transformation on infant and child mortality (both genders) estimates derived from Trussell method: Chitungwiza, 1990.

Age of child (years)	Estimated (qx)	1x of logit of 1x	yx	Standard Ysx	Yx-Ysx (a)x	Y(x)	Smoothed qx
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	0.0031	0.9969	-2.8866	-0.9972	-1.8894	-2.0220	0.0172
2	0.0231	0.9769	-1.8723	-0.8053	-1.0670	-1.8302	0.0251
3	0.0251	0.9749	-1.8297	-0.7253	-1.1044	-1.7502	0.0293
5	0.0427	0.9573	-1.5550	-0.6514	-0.9036	-1.6765	0.0338
10	0.0423	0.9577	-1.5600	-0.5498	-1.0102	-1.5748	0.0411
15	0.0365	0.9635	-1.6366	-0.5131	-1.1235	-1.5381	0.0441
20	0.0205	0.9795	-1.9333	-0.4551	-1.4782	-1.4801	0.0493

m = 27.7 years

A brief comparison of the q(x) values obtained using the Brass, Sullivan and Trussell methods shows little variation, with the Brass method showing slightly higher levels of mortality at all age groups. Since this difference is minimal, infant and child mortality levels will be estimated by gender using only the Brass weighting method. Brass estimates will be used in the determination of mortality trends and in the construction of the logit model life tables by gender.

Estimates by gender using Brass's weighting method

To estimate infant and child mortality levels, the logit transformation is used to graduate both the male and female mortality estimates produced by the Brass indirect technique (Tables 7.4 and 7.5).

Table 7.4: Application of the logit transformation on infant and child mortality (females) estimates derived from Brass's weighting method: Chitungwiza 1990

Age of child (years)	1x	Observed of 1x	Yx = logit Ysx	Standard = (a)x	Yx–Ysx (a)' + Ysx	Yx = 1x	Graduated xqx
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	0.0184	–	–	-0.9772	–	-1.9873	0.9816
2	0.0268	0.9551	-1.5287	-0.8053	-0.7235	-1.7955	0.9732
3	0.0313	0.9831	-2.0376	-0.7252	-1.3124	-1.7155	0.9687
5	0.0361	0.9598	-1.5864	-0.6515	-0.9349	-1.6418	0.9639
10	0.0439	0.9711	-1.7573	-0.5498	-1.2075	-1.5401	0.9561
15	0.0471	0.9567	-1.5477	-0.5131	-1.0346	-1.5034	0.9529
20	0.0526	0.9670	-1.6888	-0.4551	-1.2337	-1.4454	0.9474

(a)' = -0.9903

Table 7.5: Application of the logit transformation on infant and child mortality (males) estimates derived from Brass's weighting method: Chitungwiza 1990

Age of child (years)	1x	Observed of 1x	Yx = logit Ysx	Standard = (a)x	Yx–Ysx (a)' + Ysx	Yx = 1x	Graduated xqx
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	0.1135	0.8739	-0.9670	-0.9772	0.0291	-1.0276	0.8865
2	0.0236	0.9838	-2.0532	-0.8053	-1.2480	-1.8619	0.9764
3	0.0276	0.9669	-1.6873	-0.7253	-0.9620	-1.7819	0.9724
5	0.0318	0.9617	-1.6116	-0.6514	-0.9602	-1.7082	0.9682
10	0.0387	0.9543	-1.5194	-0.5498	-1.9696	-1.6065	0.9631
15	0.0415	0.9816	-1.9884	-0.5131	-1.4753	-1.5698	0.9580
20	0.1807	–	–	-0.4551	–	-1.5118	0.8193

(a)' = -1.0567

The graduated 1q0 for female infants (Table 7.4) and 20q0 for male infants (Table 7.5) should be treated with caution because they are derived from the standard Ysx only and not from the graduation of the observed 1q0 and 20q0 respectively. This is so because no female and no male children were reported dead by women in the 15–19 and 45–49 ages groups respectively.

A male infant mortality rate of 113 deaths per 1 000 live births was estimated for Chitungwiza. When compared to the ICDS (CSO, 1991) and the ZDHS (CSO, 1989) infant mortality estimates of 60 and 41 deaths per 1 000 live births, respectively, the male infant mortality rate in Chitungwiza is somewhat higher than expected. Male child mortality, 5q0, in Chitungwiza is lower than female child mortality. It can be observed that 32 male children compared to 36 female children per 1 000 die before reaching their fifth birthday.

Time location of estimates

Estimates of child mortality using the Brass (1968), Sullivan (1972) and Trussell (1975) methods tend to be high if they are interpreted as representing the mortality levels at the time of the survey. It has been shown, however, that infant and child mortality estimates obtained from data for women in a certain age group, are equivalent to corresponding values during a particular period some years before the surveys (Coale and Trussell, 1977). Therefore, mortality levels estimated by the indirect methods previously discussed refer not to the year of the interview but to some years before the interview. Using Brass's (1985) method of time location, estimates of infant and child mortality from proportions dead by age of mother, were time located to obtain the trends in infant and child mortality (Table 7.6).

Table 7.6: Time location of estimates of child mortality: Chitungwiza 1990

Age of women (years)	Age x	Male	(a) Female	a	a–m	T	Year
15-19	1	-0.0291	–	17.5	-9.8	1.56	88.4
20-24	2	-1.2480	-0.7235	22.5	-4.8	3.29	86.7
25-29	3	-0.9621	-1.3124	27.5	0.2	5.29	84.7
30-34	5	-0.9601	-0.9349	32.5	5.2	7.58	82.4
35-39	10	-0.9696	-1.2075	37.5	10.2	10.06	79.9
40-44	15	-1.4753	-1.0346	42.5	15.2	12.93	77.1
45-49	20	-	-1.2337	47.5	20.2	16.42	73.6

m = 27.7 years

The Brass method translates the lx obtained using the formula 1–qx into mortality levels for each age group. The series of alpha (a) then obtained corresponds to levels of infant and child mortality at different time points T, before 1990, the year of interview.

The values of a in Table 7.6 are the mid-points of the five-year age group of the mothers reporting. T is interpolated from a–m using the Brass table (Brass, 1985). m is the mean of the age specific fertility distribution. The measurement of m often creates problems. It is usually done from rates derived from births in the past year. m in this study is interpolated from P2/P3 using the Brass table (Brass, 1985). P2/P3 = 0.5685, which is the ratio of the mean parity of the 20–24 year age group to that of the 25–29 year age group of women. P1/P2 is not used in the interpolation of the m value because it does not lie within the given P1/P2 values in the Brass table and the author (Brass, 1985) advises that it is better or more convenient to derive m from P2/P3 using the table which he provides. In many sets of data, P2/P3 will give a better indication of the fertility distribution, especially within the middle age range of reproduction. P1/P2 is likely to better represent the pattern near the start of child-bearing.

Table 7.6 suggests that the infant and child mortality estimates refer to a time period approximately 2–16 years before the survey. Thus the infant and child mortality estimates obtained refer to the period between 1973 and 1988.

Female adult mortality

Brass and Hill (1973) orphanhood method is used to estimate levels and trends of female adult mortality. The maternal orphanhood method translates surviving parent into probabilities of survival from base age B, to age B+N. For female adult mortality B is taken as 25. Table 7.7 shows the full computation of female adult survival probabilities from one age to another. The conditional survival probabilities are usually easier to interpret when translated to levels of adult mortality, (a), as follows:

(a) = -0.5 loge (1 + NPM/ls(B+N) - (1/ls)/1-NPM.

The alpha (a) values were then time located to determine the trend of female adult mortality in Chitungwiza.

In Table 7.7, the observed alpha (a) values generally indicate very low mortality levels among female adults in the Chitungwiza area when compared with Udjo's (1991) study of the Kanuri in Nigeria, where alpha (a) levels of -0.726 (Maiduguri urban area) and -1.0570 (Marte rural area) were recorded. In the Chitungwiza study, alpha (a) values range from -0.737 to -1.1062.

When the crude proportions of those with mother alive in Chitungwiza are compared with those of Maiduguri, as shown in Table 7.8, the proportions dead in all age groups in Chitungwiza are lower than those for Maiduguri, implying lower female mortality levels in Chitungwiza than in Maiduguri. The low mortality levels of Chitungwiza are also indicated by the alpha (a) values which are lower than those for Maiduguri (Table 7.8). When time located, the female adult mortality estimates in Chitungwiza, (a), refer to a time period approximately 6–13 years before the survey year of 1990.

Table 7.7: Maternal orphanhood mortality: Chitungwiza 1990

Age group (years)	Proportion with mother alive	Central age N	W(N)	Age (25+N)	1(25+n) /125	(a)	T
10-14	0.9921						
		15	0.8134	40	0.9861	-1.1062	6.1
15-19	0.9706						
		20	0.8818	45	0.9637	-1.0762	7.9
20-24	0.9337						
		25	0.9201	50	0.9264	-0.8743	9.6
25-29	0.8717						
		30	0.9434	55	0.8708	-0.7371	10.3
30-34	0.8600						
		35	0.9023	60	0.8554	-0.8779	12.0
35-39	0.7783						
		40	0.8312	65	0.7654	-0.7966	12.8
40-44	0.6488						
		45	0.6435	70	0.6489	-0.7623	11.8
45-49	0.6496						

M = 26.7 years

Table 7.8: Proportion with mother alive and alpha (a) values in Chitungwiza and Maiduguri

Age group (years)	Proportion with mother alive		Mortality levels (a)	
	Chitungwiza	Maiduguri	Chitungwiza	Maiduguri
15-19	0.9706	0.9090	-1.1062	-0.7260
20-24	0.9337	0.8610	-1.0762	-0.4190
25-29	0.8717	0.8010	-0.8743	-0.3710
30-34	0.8600	0.7440	-0.7371	-0.3620
35-39	0.7783	0.7030	-0.8779	-0.4290
40-44	0.6488	0.5200	-0.7966	-0.3870
45-49	0.6496	0.4440	-0.7623	-0.3500

The abnormally low mortality rates may have been biased by the adoption effect (the reporting of adopted children as biological children leading to a depression of the extent of orphanhood), especially the (a) value of -1.1062, since it is based on mothers reported for persons under the age of 15 years. This is supported by the high survival probability l(25+N)/l25 of females from ages 25–40 years of 0.9861 (Table 7.7). The survival chances of females aged 40–70 years is decreasing, as would be expected. The trends in the Chitungwiza area generally suggest a dramatic improvement in female adult mortality.

Male adult mortality

The paternal orphanhood method of estimating male adult mortality follows the same principles as the maternal orphanhood method for estimating female adult mortality. With this method, the base age for male adult mortality is taken as 32.5 years. Table 7.9 shows the conditional probabilities of survival between age groups as well as mortality levels denoted by (a) values.

Table 7.9: Paternal orphanhood mortality: Chitungwiza 1990

Age group (years)	Proportion with mother alive	Central age N	W(N)	Age (25+N)	1(25+n) /125	(a)	T
10-14	0.9467						
		15	0.4978	47.5	0.9334	-0.6602	7.6
15-19	0.9202						
		20	0.4926	52.5	0.8852	-0.5817	9.6
20-24	0.8513						
		25	0.4379	57.5	0.7992	-0.4506	11.7
25-29	0.7587						
		30	0.2782	62.5	0.6760	-0.3323	13.3
30-34	0.6441						
		35	0.0684	67.5	0.5091	-0.2017	13.0
35-39	0.5177						
		40	-0.2488	72.5	0.4204	-0.3519	–
40-44	0.4398						
		45	-0.5356	77.5	0.3968	-0.2495	–
45-49	0.4118						

M = 31.74 years

The (a) values in Table 7.9 obtained using the paternal orphanhood method suggest higher male adult mortality than the female adult mortality obtained using the maternal orphanhood method. Male adult mortality estimates, (a), refer to a time period approximately 8-13 years before the survey year of 1990. These findings are consistent with findings for African countries such as Libya, Tanzania and Malawi where data reveals adult male mortality to be higher than female adult mortality (ECA, 1979). Female adult mortality has improved dramatically over the years in Chitungwiza whereas male mortality has improved moderately.

Maternal mortality

Maternal mortality levels in Chitungwiza were estimated using the sisterhood method derived by Graham et al. (1989). They devised an adjustment factor for relating the proportions of sisters dying from maternal causes reported by respondents aged u, to the probability of dying from maternal causes by age u, q(u) or q(w), the probability of death by the end of the reproductive period.

In order to calculate the proportions of sisters dying of maternal causes, the following questions were included in the household schedule survey, thus enabling the sisterhood method to be used to estimate maternal mortality in Chitungwiza:

- How many sisters born to the same mother have you ever had who were ever married (including those who are now dead)?
- How many of these ever-married sisters are alive now?
- How many of these ever-married sisters are dead now?
- How many of these dead sisters died while pregnant or during childbirth or during the six weeks after the end of a pregnancy?

The questions on ever-married sisters (born to the same mother), alive or dead, are used to check the total number of ever-married sisters. These questions were administered to all household members aged 15 years and over (unrestricted sampling). Trussell and Rodriguez (1990) examined the implications of multiple counting arising from unrestricted sampling, so that only one sister per household was allowed to respond to the questions, as was the case in the Demographic and Health Survey in Bolivia (Instituto Nacional de Estadistica and Institute for Resource Development/Macro-Systems, 1989). They concluded that unrestricted sampling provided unbiased estimates of mortality in contrast with restricted sampling which provided overestimates.

Results of the application of sisterhood method to the survey data are shown in Table 7.10.

Table 7.10 also shows the steps involved in calculating the lifetime risk of maternal mortality, q(w), by age of the respondent. For example, in the 20–24 age group, 306 respondents reported 792 sisters as ever-married, of whom only one had died during pregnancy, childbirth or the puerperium. The number of ever-married sisters, in this case 792, is multiplied by an adjusting factor of 0.206 to arrive at a figure of 163 which represents sisters' units of risk exposure (column f). Column g is calculated by dividing the only death (column d) by the 163 sisters' units of risk exposure (column f) to arrive at the figure of 0.0061. This step for calculating q(w) is carried out for each age group.

Table 7.10: Maternal mortality estimates using the sisterhood method: Chitungwiza 1990

Age group (years)	No. of respondents	Sisters ever married N(i)	Maternal deaths r(i)	Adjustment factor K(i)	Units of risk exposure B(i)	Lifetime risk of maternal death q(w)	Dying of maternal causes
(a)	(b)	(c)	(d)	(e)	(f = ce)	(g = d/f)	(h)
15-19	63	163†	1	0.107	17	0.0588	0.3333
20-24	306	792†	1	0.206	163	0.0061	0.0833
25-29	331	781	10	0.343	268	0.0373	0.2564
30-34	273	731	7	0.503	368	0.0190	0.3684
35-39	205	544	12	0.664	361	0.0332	0.8571
40-44	88	256	13	0.802	205	0.0634	1.0000
45-49	32	90	1	0.900	81	0.0123	0.0909
50-54	24	63	4	0.958	60	0.0667	0.5714
Total	1322	3420	49	—	1532	0.0308‡	0.0322

† Figures derived by multiplying the number of respondents by the average number of ever-married sisters per respondent reported for the age group 25+, that is, 2.59.

‡ The lifetime risk of maternal death from reports of respondents under 50: 45/1463 = 0.0308. Total fertility rate (TFR) is equal to seven births per woman. q(w) is the probability of maternal death by the end of the reproductive period, that is, the lifetime risk.

Graham et al. (1989) suggested adjusting underestimates of ever-married sisters in the first two age groups, by multiplying the number of respondents by the average number of ever-married sisters per respondent aged over 25 years. In the present application the average is 2.59. The results in Table 7.10 show a fluctuating pattern of the proportion of dead sisters who died of maternal causes by respondent age group. The fluctuating pattern is probably due to incorrect reporting of respondents' ages, especially of those aged over 50 years. Table 7.10 also indicates that almost one third of sisters reported dead by respondents aged under 50 years, died during pregnancy, childbirth or the puerperium. From Table 7.10 it can be observed that respondents aged 15-19 years reported the most deaths related to maternal complication a q(w) of 0.0588. This figure is higher than that calculated for the 20-24 age group (0.0061). The q(w) (probability of maternal death by the end of the reproductive period) at ages over 50 years is expected to be lower since causes of death unrelated to pregnancy naturally assume greater importance with increasing age.

Lifetime risk of maternal death from reports of respondents of all age groups ranges from 0.0061-0.0667, with an overall total of 0.0308. The estimated lifetime risk of maternal death from reports of respondents under the age of 50 is 0.0308. This may be translated into the more conventional measure of maternal mortality (maternal mortality per 100 000 live births) by the approximation suggested by Graham et al. (1989):

Maternal mortality ratio = 1 - P1\TFR

where P1 is the probability of survival and TFR is the total fertility rate.

The estimate from the Chitungwiza data is 446 maternal deaths per 100 000 live births. A maternal mortality ratio of 446 per 100 000 live births is somewhat lower than that noted by the World Health Organization (WHO, 1986) of up to 1 000 deaths per 100 000 live births for rural areas and over 500 deaths per 100 000 live births in several cities in Africa. In Addis Ababa, for example, a study revealed a rate of 566 deaths per 100 000 live births (WHO,1986). These levels (though not obtained from the sisterhood method) are somewhat higher than those obtained for the Chitungwiza urban area.

The infant and child mortality estimates in Chitungwiza were observed to be lower than the Zimbabwe urban national estimate obtained from the ZDHS (CSO, 1989). The findings from the Brass, Sullivan and Trussell indirect techniques show little variation from one another, although the Brass weighting method shows slightly higher levels of infant and child mortality. For example, the child mortality rate 5q0 (for both genders combined) estimated using the Sullivan and Trussell methods was found to be the same (34 deaths per 1 000 live births) whereas the level obtained after using the Brass method was 35 deaths per 1 000 live births. Due to the slight variation in the childhood qx estimates, from the three indirect methods, only the Brass method was used to estimate infant and child mortality by gender. In Chitungwiza, male child mortality, 5q0, was observed to be lower than female child mortality, 5q0, in each age group (32 male children and 36 female children per 1 000).

Female adult mortality (a) in Chitungwiza is lower than male adult mortality. The maternal mortality rate of 466 deaths per 100 000 live births is lower than the rate of over 500 deaths per 100 000 live births observed for some African cities (WHO, 1986). Chitungwiza can be said to be experiencing low child, adult (male and female) and maternal mortality rates.

Model life tables

There are several ways in which the partial survivorship probabilities can be used to construct complete life tables. The most common method in the African context is the logit method (Brass, 1975; Brass, 1985). A model life table generated through the use of partial survivorship data is known as a "relational life table" because it is linked to a standard life table, unlike an empirical life table which is generated from registered deaths (Newell, 1988).

The logit system relates the logit of a standard model life table lx values to the logits of Yx of the derived life table lx as follows:

$Yx = (a) + (b)Ysx$

where Yx is 0.5 log [(1-lx)/lx] and the s defines a standard pattern of lsx. The parameter alpha (a) defines the general level of mortality in the population whilst beta (b) describes the relationship between child and adult mortality (Brass, 1975; Newell, 1988).

The "African standard", lsx, constructed to represent an average pattern over all populations, has been the base for many time location applications. For this purpose (b) is taken to be 1, reducing the system to a one parameter set of model life tables (Brass, 1985).

One parameter logit model life tables

In order to construct one parameter logit life tables for each gender at childhood and adulthood, beta (b) was assumed to be equal to 1. The alpha (a) values, for 1982 for female childhood and adulthood, used in the construction of the one parameter logit life tables are -0.9349 (Table 7.6) and -1.0762 (Table 7.7) respectively. For male childhood (a) is -0.9601 (Table 7.6) and for adulthood (a) is -0.6602 (Table 7.9).

After the construction of two, separate, one parameter logit life tables for childhood and adulthood, the two are then "spliced" or joined together to create a hybrid one parameter life table. Before splicing, the probability of surviving from age 15 to 15+N years in the female and male adult one parameter life table was estimated as lA(15+N)/lA15, where A denotes female or male adult survival probability. The proportions surviving to exact ages in female and male adulthood were derived as the product of the probability of surviving from age 15 to age 15+N years and the childhood survival probability at age 15 years.

Two parameter logit model life tables

The two parameter logit model system turns out to be a convenient tool for deriving a consistent mortality pattern for Chitungwiza. Two parameter logit life tables for Chitungwiza were constructed for 1982 so as to compare them with life tables established by the 1982 Census (CSO, 1985) and other surveys carried out in Zimbabwe. Brass's two parameter model life tables is based on the expression:

$Yx = (a) + (b)Ysx$

where alpha (a) defines the general level of mortality in the population whilst beta (b) describes the shape of the mortality curve. In demographic terms, this refers to the relationship between childhood and adult mortality (Newell, 1988; Brass, 1975).

Beta (b) was estimated from the hybrid life tables for each gender using the equations:

Y5 = (a) + (b)Ys5 and YH60 = (a) + (b)Ys60

where s and H denote the African standard and hybrid life tables respectively.

From these equations

(b) = (Y5 - YH60)/(Ys5 - Ys60).

Using the estimated (b) values for male and female, new (a) values which define the general level of mortality in the population were estimated as:

(a) = Y5 - (b)Ys5.

According to Newell (1988), for beta (b) to be reasonable it should range from 0.6–1.4 though this depends to some extent on which standard is being used. For female, the alpha (a) value was estimated to be -1.0101 and the beta (b) value to be 0.8846, while for male the estimated alpha (a) and beta (b) values are -0.7885 and 1.2634 respectively. Using these new alpha (a) and beta (b) values, two parameter model life tables were then constructed for Chitungwiza for 1982. Tables 7.11 and 7.12 show the results of the application of the relational two parameter logit system and the use of Barclay's (1958) technique to construct a full life table.

Table 7.11: Two parameter logit life table for females: Chitungwiza 1982

Age (years) x	n	lx	ndx	nqx	Lx	Tx	ex
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
0	1	10 000	222	0.0222	9839	702848	70.3
1	1	9 778	87	0.0089	9727	693009	70.9
2	1	9 691	46	0.0047	9668	683282	70.5
3	1	9 645	27	0.0028	9631	673614	69.8
4	1	9 618	20	0.0021	9608	663983	69.0
5	5	9 598	76	0.0079	38619	654375	68.2
10	5	9 522	30	0.0031	47535	615756	64.7
15	5	9 492	52	0.0055	47330	568221	59.9
20	5	9 440	71	0.0075	47022	520891	55.2
25	5	9 369	75	0.0080	46657	473869	50.6
30	5	9 294	80	0.0086	46270	427212	46.0
35	5	9 214	92	0.0100	45840	380942	41.3
40	5	9 122	111	0.0122	45332	335102	36.7
45	5	9 011	144	0.0160	44695	289770	32.2
50	5	8 867	197	0.0222	43842	245075	27.6
55	5	8 670	283	0.0326	42642	201233	23.2
60	5	8 387	427	0.0509	40867	158591	18.9
65	5	7 960	700	0.0879	38130	117724	14.8
70	5	7 292	1065	0.1460	33792	79594	10.9
75	5	6 225	2343	0.3764	25267	45802	7.3
80	5	3 882	2094	0.5394	14175	20535	5.3
85	5	1 788	1032	0.5772	6360	6360	3.5

From Table 7.1 the e(o), that is, life expectancy at birth, for a female child born in Chitungwiza is on average 70.3 years. If the female child survives the first year of life, the life expectancy increases very slightly by a margin of 0.6 years. For a male child born in Chitungwiza, life expectancy at birth is 64.6 years. Male child survival past the first year of life raises this by 0.1 years (Table 7.12).

Table 7.12: Two parameter logit life table for males: Chitungwiza 1982

Age (years) x	n	1x	ndx	nqx	Lx	Tx	ex
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
0	1	10 000	164	0.0164	10058	646287	64.6
1	1	9 836	99	0.0101	9778	636229	64.7
2	1	9 737	57	0.0058	9708	626451	64.3
3	1	9 680	36	0.0037	9662	616743	63.7
4	1	9 644	27	0.0028	9630	607081	62.9
5	5	9 617	107	0.0111	47817	597451	62.1
10	5	9 510	45	0.0047	47437	549634	57.8
15	5	9 465	79	0.0083	47127	502197	53.1
20	5	9 386	144	0.0121	46645	455070	48.5
25	5	9 272	125	0.0135	46047	408425	44.0
30	5	9 147	138	0.0151	45390	362378	39.6
35	5	9 009	164	0.0182	44635	316988	35.2
40	5	8 845	206	0.0233	43710	272353	30.8
45	5	8 639	277	0.0321	42502	228643	26.5
50	5	8 362	389	0.0465	40837	186141	22.3
55	5	7 973	572	0.0717	38435	145304	18.2
60	5	7 401	861	0.1163	34852	106869	14.4
65	5	6 540	1273	0.1946	29517	72017	11.0
70	5	5 267	1710	0.3247	22060	42500	8.1
75	5	3 557	1806	0.5077	13270	20440	5.7
80	5	1 751	1230	0.7025	5680	7170	4.1
85	5	0.052	446	0.8560	1490	1460	2.8

The differentials in life expectancy at birth for Chitungwiza and for Zimbabwe as a whole, show significant mortality variations. When the Chitungwiza life expectancy for females is compared with the national figure, obtained from the 1982 Census (CSO, 1985) and other surveys conducted in Zimbabwe (Table 7.13), a significant difference is observed. The national life expectancy at birth is depressed by the inclusion of the rural population which comprises 73% of the total. In Table 7.13, female life expectancy at birth, estimated by the 1982 Census (CSO, 1985), is 57.2 years whereas that estimated from the CSDS (University of Zimbabwe, 1990) is 70.3 years, a difference of 13.1 years. By 1986, life expectancy at birth for Zimbabwean females had improved to 62.7

years (CSO, 1989). Life expectancy at birth for Chitungwiza females is 7.6 years higher. Male life expectancy at birth in 1980 varied from 56.2 years for Zimbabwe as a whole (CSO, 1985) to 64.6 years for Chitungwiza (Table 7.13).

Table 7.13: **Estimates of life expectancy at birth e(o) for Zimbabwe and Chitungwiza by gender**

Source	Reference date	Male	Female
1982 Census	1980	56.2	57.1
1987 ICDS	1985	57.9	62.9
1988 ZDHS	1986	61.4	62.7
1990 CSDS	1982	64.6	70.3

Source: *Combined Demographic Analysis Report* (CSO, 1992)

The difference between the male life expectancy estimate for 1980, from the 1982 Census (CSO, 1985), and for 1982, from the CSDS (University of Zimbabwe, 1990) is 8.4 years. The high life expectancy at birth for Chitungwiza is due to the low infant and child levels reflected in Tables 7.14 and 7.15. For Chitungwiza, the total mortality rates for males and females in the first five years of life (5q0) is estimated to be 402 and 383 deaths per 1 000 respectively.

The life expectancy at birth in Chitungwiza, for both males and females (64.6 and 70.3 years respectively), reflects a greater concentration of medical facilities plus higher socio-economic development than many other parts of the country. The increase in the life expectancy at birth if infants survive the first year of life is very slight; 0.6 years for females and 0.1 years for males.

Summary and conclusions

In the evaluation of the data collected during the Chitungwiza Socio-Demographic Survey (University of Zimbabwe, 1990), sample unrepresentativeness and irregularities in the proportions of children dead (CDi) were found in the data. Lack of representation of an age group in the entire sample may have been caused by misreporting of the mothers' own birth dates and because there are likely to be few women in the 15-19 age group with births. Misreporting of birth dates can be due to preference for certain terminal digits (known as heaping) or the wholesale transfer of the birth dates into certain age groups. Fluctuation of proportions of children dead (Di) by age group of mother was caused by underreporting of deaths in certain age groups such as 35-39, 40-44 and 45-49. As a result of these errors, the observed qx (the probability of dying between birth and exact age x) fluctuated from one age group to another, instead of increasing with the age of the mother. The need to graduate the mortality estimates became apparent because of the irregularities of qxs estimated by the

Brass, Sullivan and Trussell methods. Brass's logit system (1975) was used in the graduation of the qx estimates derived after the use of the three indirect methods. The smoothed qxs were adopted for analyzing mortality levels in Chitungwiza.

Infant mortality estimates obtained after the application of the Brass and Trussell methods were treated with caution because:

- Children born to teenage mothers face relatively higher risks of death than children born to older mothers, resulting in inadequate representation of mortality experience of children born to women aged 15–19 years.
- Reports by women aged 15–19 years of the number of children dead are based on relatively small numbers and hence have higher sample variability.

The male infant mortality rate in Chitungwiza was estimated to be 113 deaths per 1 000 live births. This rate is much higher than that of 60 deaths per 1 000 live births estimated by the 1987 ICDS (CSO, 1991) and 41 deaths per 1 000 live births reported by the ZDHS (CSO, 1989). The tabulated female infant rate of 18 deaths per 1 000 live births should be treated with caution because it is obtained after taking the antilogit of Yx of age 1 but not after graduating the observed qx.

Childhood mortality estimates (5q0) from the Chitungwiza data using the Brass, Sullivan and Trussell methods are lower than the ungraduated estimate from the ZDHS (CSO, 1989). Using the Chitungwiza data, the Brass (1968) method estimated 5q0 to be 35 deaths per 1 000 live births whereas the Sullivan (1972) and Trussell (1975) methods yielded the same 5q0 estimate of 34 deaths per 1 000 live births. On a comparative basis the CSDS (University of Zimbabwe, 1990) estimates are lower than the unadjusted ZDHS (CSO, 1989) estimate of 55 deaths per 1 000 live births.

Due to the retrospective nature of the data and the changing mortality conditions in Zimbabwe, a reference period for the childhood mortality estimates for each age group had to be computed.

The paternal and maternal orphanhood method (Brass and Hill, 1973) was used in estimating adult mortality in Chitungwiza. The general finding was that female adult mortality levels, (a), are lower than male adult mortality levels, also (a), at all time reference periods. When the alpha (a) values for females and males were plotted against the reference time period, the trends in Chitungwiza suggest a greater improvement in female adult mortality than in male mortality.

Lifetime risks of maternal death q(w) for sisters ever married in Chitungwiza were estimated using the sisterhood method of Graham et al. (1989) Due to the size of the sample, an estimate of the lifetime risk of maternal death from the respondents under the age of 50 was calculated to be 0.0308. This figure was converted into a more conventional measure of maternal mortality for the whole of Chitungwiza. The estimate obtained was 446 maternal deaths per 100 000 live births. The number of maternal deaths in Chitungwiza was found to be lower than the number of maternal deaths recorded in some other African urban areas (WHO, 1986).

A high life expectancy at birth, e(o), for Chitungwiza females and males is expected because of the low mortality levels estimated at childhood and adulthood. Life expectancy at birth is estimated at 70.3 years for females and at 64.6 years for males. Even though the life expectancy for Zimbabwean females improved from 56.2 years (CSO, 1985) to 61.4 years (CSO, 1989), the range between the latest estimate for Zimbabwe (61.4 years) and Chitungwiza (70.3 years) is still large. The fact that the e(o) for Chitungwiza refers to the year 1982 whereas the latest Zimbabwean estimate refers to the year 1986 should be taken into consideration.

The low child, adult (female and male) and maternal mortality levels in Chitungwiza have been caused by the concentration of medical facilities plus high levels of socio-economic development in the area. Other factors such as clean water supplies and garbage removal have contributed to the well-being of the Chitungwiza population, leading to low child and adult mortality rates (CSO, 1989).

The general findings on mortality in Chitungwiza, using the indirect techniques previously described and evaluated, suggest that Chitungwiza, as an urban centre, is experiencing low death rates in all age groups. The Chitungwiza mortality estimates are based on a small sample size, with large sampling errors likely, hence firm conclusions cannot be drawn from these estimates which should be regarded with caution.

Any future census and survey to be carried out in Zimbabwe should include sisterhood and orphanhood questions so as to obtain maternal and adult mortality estimates and a full picture of the mortality conditions of the population. Past surveys, such as the Zimbabwe Reproductive Health Survey (ZNFPC, 1985), the Intercensal Demographic Survey Round One (CSO, 1991) and the Zimbabwe Demographic and Health Survey (CSO, 1989), produced only infant and child mortality estimates. It was not possible to produce estimates of adult mortality because the data required for such estimates was not available from the surveys. The mortality estimates obtained after the use of the sisterhood and orphanhood methods combined with infant and child mortality estimates will prove valuable for health planning and policy making.

Literature cited

Barclay, G.W. 1958. *Techniques of Population Analysis*. New York: Wiley.

Blacker, J.G. 1977. The estimation of adult mortality in Africa from data on Orphanhood. *Population Studies* 31: 107-28.

Blacker, J.G. and G.J. Mukiza. 1988. The indirect measurements of adult morality in Africa: results and prospects. In *African Population Conference*. Dakar: IUSSP.

Brass, W. et al. 1968. *The Demography of Tropical Africa*. Princeton: Princeton University Press.

Brass, W. 1975. *Methods for Estimating Fertility and Mortality from Defective Data*. Chapel Hill: University of Carolina.

Brass, W. 1985. *Advances in Methods for Estimating Fertility and Mortality from Limited and Defective Data*. London: University of London.

Brass, W. and K.H. Hill. 1973. Estimating Adult Mortality from Orphanhood. In *IUSSP International Population Conference* 3: 111-23. Liege: IUSSP.

Central Statistical Office (CSO). 1985. Main Demographic Features of the Population of Zimbabwe: An Advanced Report Based on the Ten Percent Sample. Harare: CSO.

Central Statistical Office (CSO). 1989. Zimbabwe Demographic and Health Survey (ZDHS). Harare: CSO.

Central Statistical Office (CSO). 1991. Intercensal Demographic Survey (ICDS). Harare: CSO.

Coale, A.J. and P. Demeny. 1983. *Regional Model Life Tables and Stable Population*. 2d ed. London: Academic Press.

Coale, A.J. and T.J. Trussell. 1974. Model Fertility: Variation in the Age Structure of Childbearing in Human Populations. *Population Index* no. 19.

Coale, A.J. and T.J. Trussell. 1977. Estimating the Time to which Brass Estimates Apply. *Population Bulletin of the United Nations* no. 10. New York.

Economic Commission for Africa (ECA). 1979. Population Dynamics: Fertility and Mortality in Africa. *Proceedings of the Expert Group Meeting on Fertility and Mortality Levels and Trends in Africa and their Policy Implications*, Monrovia: UN Population Division.

Graham, W. et al. 1989. Estimating Maternal Mortality: The Sisterhood Method. *Studies in Family Planning* 20, no. 3: 125-36.

Hill, K and T.J. Trussell. 1977. Further developments in indirect mortality estimation. *Population Studies* 31, no. 2: 313-34.

Instituto Nacional de Estadistica and Institute for Resource Development/Macro-Systems. 1989. *Demographic and Health Survey in Bolivia*.

Newell, C. 1988. *Methods and Models In Demography*. New York: The Guilford Press.

Preston, S.H. 1985. Mortality in Childhood: Lessons from WFS. In *Reproductive Change in Developing Countries*, ed. J. Cleland and J. Hobcraft. Oxford: Oxford University Press.

Sivamurthy, M. et al. 1980. *A Handbook of Indirect Methods for Mortality Estimation*. Cairo: Cairo Demographic Centre.

Sullivan, J.M. 1972. Models for Estimation of the Probability of Dying Between

Birth and Exact Ages of Early Childhood. *Population Studies* 26, no. 1.
Trussell, T.J. 1975. A Re-estimation of the Multiplying Factors for the Brass Technique for Determining Child Survival Rates. *Population Studies* 29, no. 1: 97-107.
Trussell, T.J. and G. Rodriguez. 1990. A Note on the Sisterhood Estimator of Maternal Mortality. *Studies in Family Planning* 21, no. 6: 344-6.
Udjo, E.O. 1991. Adult Mortality from Information on Orphanhood and Widowhood among the Kanuri of Nigeria. *Journal of Biosocial Science* 23: 155-65.
United Nations. 1967. Methods of Estimating Basic Measures from Incomplete Data. *Population Studies* no. 42.
United Nations. 1983. Indirect Techniques for Demographic Estimations. *Population Studies* no. 81. New York.
United Nations. 1988. Mortality of Children under Age 5: World Estimates and Projections 1950–2025. *Population Studies* no. 105.
University of Zimbabwe. Demographic Unit. 1990. *Chitungwiza Socio-Demographic Survey*. Harare: University of Zimbabwe.
World Health Organization. 1986. *Maternal Mortality Rates: A Tabulation of Available Information*. 2d. ed. Geneva: WHO.
Zimbabwe National Family Planning Council (ZNFPC). 1985. Zimbabwe Reproductive Health Survey (ZRHS). Harare: ZNFPC.