ZIMBABWE FURTHER ANALYSIS

Trends and Differentials in Child Mortality: Zimbabwe, 1970-1994

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Zimbabwe Further Analysis

Trends and Differentials in Child Mortality: Zimbabwe, 1970-1994

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The ZDHS further analysis is part of the worldwide Demographic and Health Survey (DHS) program, which is designed to collect data on fertility, family planning, and maternal and child health. Additional information about the Zimbabwe further analysis project may be obtained from the Central Statistical office, P.O. Box 8063, Causeway, Harare, Zimbabwe (Telephone: 706-681, Fax: 708-854). Additional information about the DHS program may be obtained by writing to: DHS, Macro International Inc., 11785 Beltsville Drive, Calverton, MD 20705 (Telephone 301-572-0200, Fax 301-572-0999).

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Preface

One of the important contributions from the 1994 Zimbabwe Demographic and Health Survey Project is the series of collaborative analyses emanating from the survey. These analyses were funded by USAID/Zimbabwe and are intended to inform health and family planning policy development.

A significant objective of the further analysis effort was to facilitate a collaborative link between individuals and institutions in Zimbabwe and researchers working in the international arena. The present paper represents one of the important "fruits" of that investment. "Trends and Differentials in Child Mortality, 1970-1994" presents findings of analyses that use both the 1994 ZDHS and previous 1988 ZDHS data to examine time trends in mortality in young children as well differences in mortality risk among populations subgroups. We hope that this descriptive look at the survival chances of our most vulnerable population will spur further investigation into means to improve their lot.

We extend our thanks to the Central Statistical Office for collecting the ZDHS data and thus making this analysis possible.

Martin Vaessen
DHS Project Director

Introduction

Measurement of child mortality in Zimbabwe has not generated the controversy that has surrounded fertility measurement. It is widely accepted that child mortality has been declining for several decades, and that it has reached levels that are quite low by the standards of sub-Saharan populations. Thus according to a recent UNICEF review (Hill et al.,1997) the under-five mortality rate (U5MR, the probability of dying by age five per 1,000 live births) halved from 1960 to 1990, reaching a level of 80 per thousand in 1990. This rate of decline is similar to the rate of decline in Kenya, though Zimbabwe has somewhat lower levels than Kenya. However, the rate of decline is slower in Zimbabwe than in neighboring Botswana, though somewhat faster than in Zambia or Lesotho.

Although it is widely accepted that child mortality has declined in Zimbabwe, little is known about the precise pattern of the decline, or about differentials between population subgroups, or about the roles of various development-related changes on the decline. In this paper, data are used from the 1987-88 and 1994 Zimbabwe Demographic and Health Surveys (DHS) to explore questions about the timing of change, about differentials, and about the factors associated with change, in particular the relative contributions of improvements in education versus the effects of declining fertility. The impact of the HIV epidemic on child mortality in the most recent period is also considered.

Data Sources

Data for the study come from the 1987-88 and 1994 Zimbabwe DHSs. Both surveys used a birth history methodology to obtain information from sampled women about the date of birth and, if applicable, age at death of each of their children. Such data permit the calculation of life tables for specific time periods. The surveys also collected a substantial amount of background information about the woman. This information has been used both as the basis for calculating separate life tables for different groups and also for a multivariate analysis of infant mortality risks. Data have been used from the two surveys separately to demonstrate that the data are acceptably consistent, and then, wherever possible, data were analyzed for the two surveys together to increase sample size.

Methods

Direct estimates of the infant mortality rate (IMR, the probability of dying by first birthday per 1,000 live births), young child mortality rate (${}_4q_1$, the probability of dying between first and fifth birthdays) and under-five mortality (U5MR, the probability of dying by age five) were made for the period 1970 to 1987 from the 1987-88 ZDHS birth histories and for 1970 to 1994 from the 1994 ZDHS birth histories. All three rates were calculated for two-year time periods to provide some degree of smoothing. The life table calculations were performed by cumulating events (deaths) and exposure time for children within narrow age ranges for each time period. Mortality rates for each age range were than calculated, and converted into probabilities of dying assuming a linear survival curve within each age range. The individual probabilities were then chained together to obtain the summary measures listed above.

Life tables are of limited value for examining differentials in mortality, since a life table requires large numbers of observations. In the second part of this paper, multivariate analysis of mortality risks in infancy is carried out using logistic regression. For the logistic regression, the unit of analysis is the individual child; however, to allow for possible clustering and unobserved variables, a random effects model with standard errors adjusted for clustering at the sample cluster level has been used.[1]

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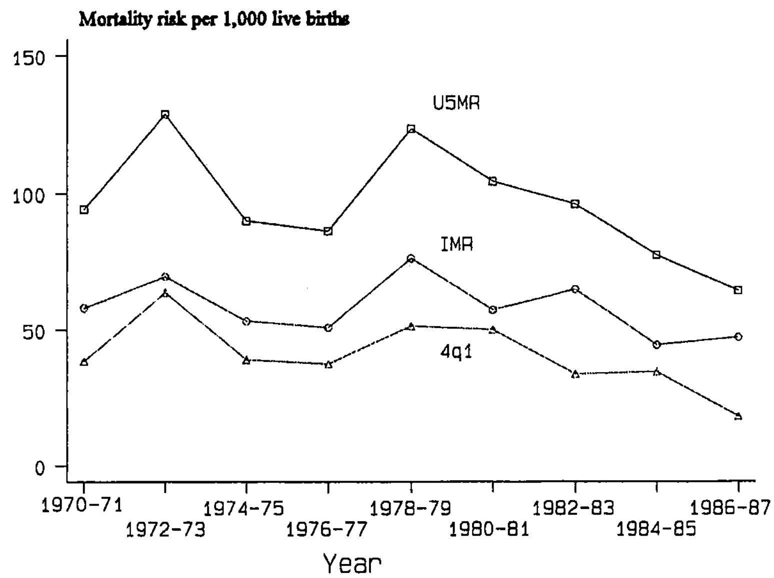
[1] Specifically, the STATA xtgee routine was used, with clustering on sample cluster and exchangeable within group correlation structure.

Results

Child Mortality Trends

Figure 1 shows the IMR, ${}_4q_1$, and U5MR for two-year periods for 1970 to 1987 from the 1987-88 DHS.

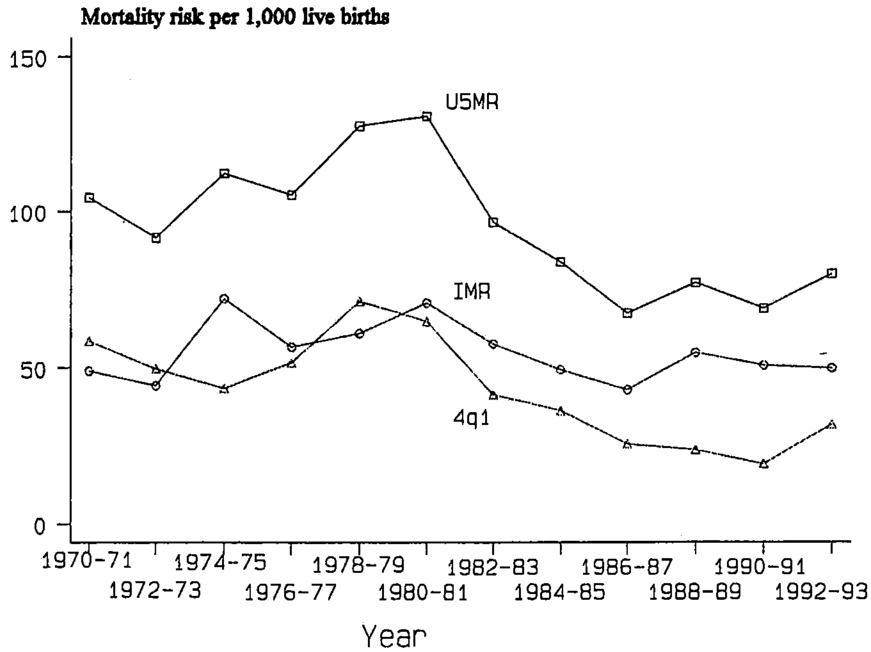
Figure 1 IMR, young child mortality, and U5MR, 1970 to 1987; Zimbabwe, 1988 DHS



The data show an overall decline in mortality from 1970-71 to 1986-87. Mortality apparently fluctuated with no clear trend from 1970-71 to 1978-79, with the U5MR between 90 and 130 per thousand, but then began a steady decline through the 1980s. The largest declines appear to have occurred in ${}_4q_1$, with somewhat smaller declines in the IMR. However, sample sizes are small and confidence intervals wide for estimates calculated for two-year periods, so the data should not be overinterpreted.

Results from the 1994 DHS in Figure 2 confirm the pattern of child mortality change from the 1987-88 DHS shown in Figure 1. After a period of varying (and possibly rising) child mortality in the 1970s, a major decline in all child mortality indices occurred in the period 1980 to 1987. Since 1987, however, the data from the 1994 DHS suggest that there has been little further decline in child mortality. Thus three periods of mortality evolution can be distinguished: 1970-79 is identified as a period of high mortality; from 1980 to 1987 there were large declines in mortality; since 1988, child mortality appears to have stagnated but at a lower level than prior to 1980. The 1994 DHS data also support the finding that mortality between the ages one and five has declined faster than mortality in infancy.

Figure 2 IMR, young child mortality, and U5MR, 1970 to 1994; Zimbabwe, 1994 DHS

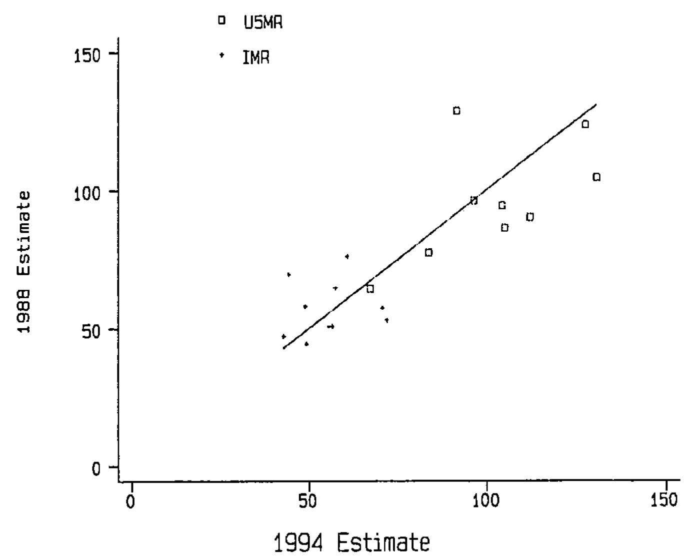


Consistency Between the Two Surveys

The 1987-88 and 1994 DHS surveys provide independent estimates of infant and child mortality for comparable two-year time periods from 1970 to 1987. Figure 3 plots the IMR and U5MR for each time period estimated from the 1987-88 survey against the comparable estimate from the 1994 survey. Also shown is the diagonal for which the 1987-88 and 1994 estimates would be equal, implying perfect agreement. For the IMR, there is some scatter around the diagonal, but no clear systematic difference. For the U5MR, on the other hand, the points tend to lie below the diagonal, especially at the higher mortality levels, indicating 1994 estimates that are higher than the 1987-88 estimates for the same time period. Most of the scatter is probably the result of sampling error, but there may be some nonrandom error in the 1987-88 estimates for the early and mid 1970s. Because of the retrospective nature of birth histories, data are likely to be of poorer quality the further back in the past to which they refer. Such error could explain the U5MR differences, though it should also be remembered that the number of observations also falls as one moves back in time from the survey, thus increasing the potential for sampling error.

The period of large mortality decline, which occurred during the early days of political independence, was a period during which immunization and other disease prevention programs were rapidly expanded. The impact of these programs may account for the fall in mortality, particularly between the ages of one and four. The period of stable or increasing mortality in the most recent years could be explained by worsening economic conditions, or by the impact of the HIV epidemic, or both; the relative contributions of these factors will be explored further in the multivariate analysis.

Figure 3 IMR and U5MR estimates from 1987-88 and 1994 DHS compared



Mortality Differentials by Region

From each survey, direct estimates of probabilities of dying were estimated by regional groupings. Regions have been formed by grouping provinces with similar ethnic compositions. The Northern Region consists of the three provinces of Mashonaland East, Mashonaland West, and Mashonaland Central. The Southwestern Region consists of the provinces of Matabeleland North, Matabeleland South, and Midlands. The Eastern Region combines the two provinces of Masvingo and Manicaland. The fourth region, which we have called Metropolitan, combines the two major cities of Harare and Bulawayo. Although the region boundaries tend to fit closely with ethnic groupings in the case of the Northern and Southwestern Regions, the Eastern Region combination of the provinces of Masvingo and Manicaland was made more for convenience, and is not ethnically homogenous.

One problem that affects child mortality estimates by region is that DHS surveys classify women by residence at the time of interview, with no indication of previous residence. It is thus not possible to classify a woman's children by her residence at the time of the birth or their overall exposure to mortality risk, so it is not possible to allow for migration effects. Regional comparisons are also affected by boundary changes, though such changes were few from the early 1980s to the mid 1990s, particularly changes that have an impact on the large regions defined here. To minimize possible distortions due to residence and boundary changes, child mortality estimates for these regions were calculated only for the five years before each survey. Table 1 shows the results from both surveys.

For the period 1983-88, the Eastern Region had the highest U5MR, followed by Northern, Southwestern, and Metropolitan with the lowest. However, given the ethnic diversity of the Eastern Region, this finding is hard to interpret. The relatively low mortality of the Southwestern Region has been confirmed by the 1992 population census (CSO, 1994).

The 1994 survey reveals a different picture. The Northern Region has the highest mortality, and the Eastern Region has the lowest, though the differences between the primarily rural regions are very small, less than 10 per thousand in U5MR. Comparison of the 1987-88 and 1994 estimates suggests that both the Southwestern and Northern Regions have experienced some mortality increase from the mid-1980s to the early 1990s. The change in the Southwestern Region (24 percent increase in U5MR from 1983-88 to 1990-94) is large, too large to be explained by boundary changes alone; the change in the Northern Region is small (9 percent for the same time period). One can only speculate as to which of a number of factors, including migration, boundary changes, real increases in child mortality, and improving data quality between one survey and the next may have accounted for these increases. U5MR in the Eastern Region and in the Metropolitan Region declined over the period, though not very rapidly.

Table 1 Child mortality estimates by region: Zimbabwe 1983-1994

Region	1983-88 (1987-88 DHS) IMR	$_4q_1$	U5MR	1990-1994 (1994 DHS) IMR	$_4q_1$	U5MR
Northern	55.4	26.3	80.3	63.9	26.3	88.6
Southwestern	49.6	14.2	63.0	49.8	34.9	83.0
Eastern	56.9	46.2	100.5	57.6	23.0	79.3
Metropolitan	31.8	7.2	38.8	18.8	15.3	33.8

Mortality Differentials by Residence

Child mortality estimates by residence of the mother suffer from the same problems of migration and boundary change effects as regional estimates, so such estimates were calculated for the five years before each survey. Table 2 shows that urban childhood mortality is lower than rural, but that from the period 1983-88 to the period 1990-94 childhood mortality was increasing for urban mothers but falling for rural mothers, so that urban-rural differentials narrowed sharply, particularly between the ages of one and five.

The increasing mortality for urban areas in the recent period is surprising in view of the fact that Harare and Bulawayo, which are 100 percent urban and account for a large proportion of the total urban population, have very low (and falling) mortality compared to the largely rural regions (Table 1). This apparent inconsistency was further explored by making child mortality estimates by residence for the three largely rural regions, each of which has an urban population in the range of 5 to 10 percent. Thus three types of residence categories are defined: rural (the rural population of the Northern, Southwestern and Eastern Regions); other urban (the urban population of the same three regions, largely provincial centers and growth points); and Metropolitan (the entirely urban populations of Harare and Bulawayo). Table 3 shows estimates for these three types of residence.

Table 2 IMR, $_4q_1$, and U5MR by urban-rural residence

Residence	1983-88 (1987-88 DHS) IMR	$_4q_1$	U5MR	1990-1994 (1994 DHS) IMR	$_4q_1$	U5MR
Urban	35.0	11.5	46.1	45.7	23.5	68.1
Rural	56.8	31.1	86.1	52.8	27.0	78.4
Percent difference	38	63	26	15	10	13

Table 3 IMR, $_4q_1$, and U5MR by rural, other urban and metropolitan residence

Residence	1983-88 (1987-88 DHS) IMR	$_4q_1$	U5MR	1990-94 (1994 DHS) IMR	$_4q_1$	U5MR
Rural	56.8	31.1	86.1	52.8	27.0	78.4
Other urban	38.5	15.9	53.8	99.8	39.1	135.1
Metropolitan	31.8	7.2	38.8	18.8	15.3	33.8

The results show very high mortality for the other urban areas in the period 1990-94. Child mortality risks declined for both rural areas and the metropolitan areas between 1983-88 and 1990-1994, but the IMR and U5MR in other urban areas increased by nearly 150 percent. It is important to stress however that the numbers of children in other urban areas upon which the estimates are based are small and potential sampling errors are high; for example, the U5MR estimate of 135.1 for other urban areas in the period 1990-94 has 95 percent confidence intervals of 64.4-231.8.

HIV/AIDS could be a major contributor to this increasing mortality in the other urban areas because people tend to migrate to a nearby town when they fall sick. However, it is not possible to establish a link between childhood mortality and HIV/AIDS using estimates of child mortality that are based on mother's reports of their own children. For a mother to report the death of a child, she must herself be alive at the time of the survey. However, for the child to be infected, the mother must be infected, so mothers of infected children are themselves more likely to have died, and to be unable to report the death of the infected child. The result of this correlation between the risks to the mother and the risks to the child is that only a small proportion of childhood deaths due to AIDS are likely to be picked up by the survey. A substantial number are likely to go unreported, because the mother herself has died before the survey.

HIV prevalence data support the hypothesis that the HIV epidemic may explain the rising child mortality in other urban areas. Smaller towns generally have higher HIV prevalence rates than Harare and Bulawayo. Table 4 shows the HIV prevalence rates for selected towns for 1995 based on data from sentinel surveillance of women seeking antenatal care.

Results from Pooled Data

To increase sample size, the 1987-88 and 1994 DHS data sets were pooled together to make one data set which was used to make robust estimates of probabilities of dying by sex of child and by educational level of mother. The similarities in data collection and sampling procedures between the two surveys, and the similarity of the estimates from the two surveys in Figure 3, suggest that the data sets can be combined without serious reper-cussions for the analysis.

Table 4 HIV prevalence from ANC data for selected urban areas

Town	HIV prevalence from ANC-base year 1995
Mutare urban	36.6 (Manicaland)
Bindura urban	40.0 (Mashonaland C)
Kadoma urban	25.5 (Mashonaland W)
Hwange urban	35.5 (Matabeleland N)
Beitbridge	23.0 (Matabeleland S)
Gweru urban	34.5 (Midlands)
Harare	34.5
Bulawayo	27.8
Masvingo	36.0 (Masvingo)
Marondera	40.0 (Mashonaland E)

Source: Ministry of Health and Child Welfare, National AIDS Coordination Program. Quarterly Report, September-December 1995.

The pooled data have been used to make estimates of childhood mortality by sex of child and by education of the mother. For both variables, it was assumed that the classification of sex of child and education of mother is unlikely to change with time, so that retrospective data can be used to examine long-term trends. Infant and under-five mortality probabilities of dying were calculated for 5-year periods from 1970 onward.

Figure 4 and Table 5 show that child mortality is highest among women with no education, and lowest for women with secondary and higher education. Women with no education have made the largest gains in reducing child mortality; the IMR for children of women in this category has fallen by 48 percent in the period 1970-74 to 1990-94, compared to a fall of 23 percent among those with primary education and no clear trend for women with secondary or higher education. All educational categories experienced substantial falls in mortality during the period 1980-84 to 1985-1989 but those with primary and secondary education did not maintain this advantage: the mortality of their children appears to have increased in the

Childhood Mortality by Education of Mother

Figure 4 and Table 5 show IMR and U5MR by mother's educational category and five-year time period.

Figure 4 Probabilities of dying before age 5, by mother's education, 1970 to 1994

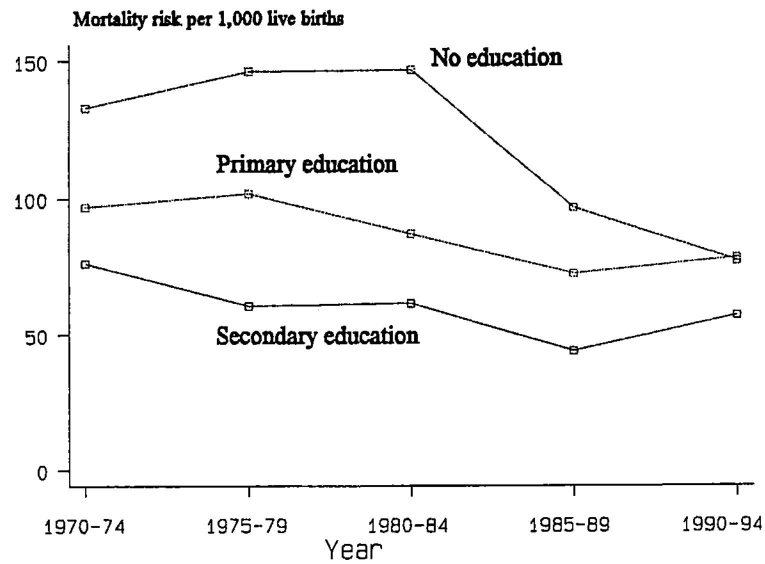


Table 5 IMR and U5MR by time period and educational level of mother: pooled data

Time period	Infant mortality rate			Under-five mortality rate		
	No education	Primary	Secon-dary+	No education	Primary	Secon-dary+
1970-74	76.9	50.9	35.3	132.8	96.8	76.0
1975-79	72.6	59.2	55.5	146.1	101.7	60.4
1980-84	85.2	52.4	34.8	146.6	86.9	61.4
1985-89	63.2	49.8	32.9	96.4	72.2	43.8
1990-94	51.4	55.4	41.5	76.9	78.0	56.9

period 1990-94. The pattern of change in differentials by education of mother seen in Figure 4 during the period 1980-89 is consistent with the government-supported expansion of primary health care services during the post-independence period. Such primary health care services, and particularly the preventive components of those services, are likely to benefit disproportionately those with no education, thus contributing to the narrowing child mortality differentials in the 1980s. In the early 1990s, the no education group appears to have achieved a child mortality level similar to that of the primary education group, and the differential relative to the secondary plus group narrows still further; this pattern may be partly the result of differential impacts of HIV infection by education of mother.

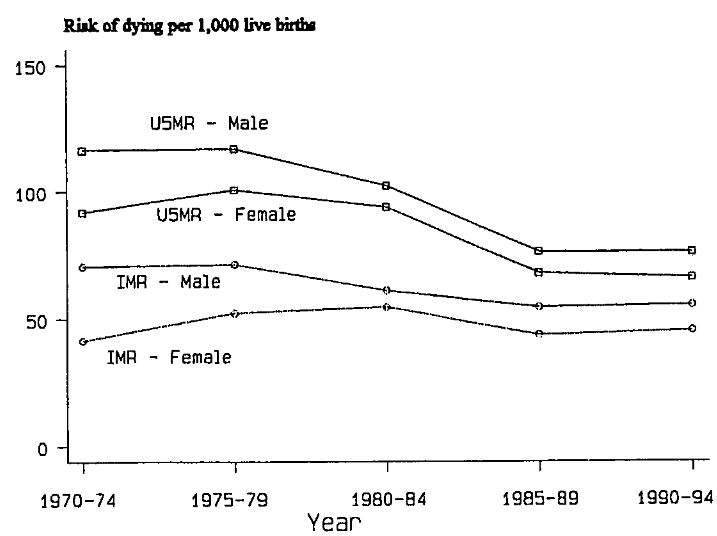
Child Mortality by Sex

From the pooled data, estimates of probabilities of dying in childhood were made for male and female children separately. The results, shown in Table 6 and graphically in Figure 5, indicate that mortality of female children is consistently lower than that of male children. Both sexes have experienced declines from 1980 to 1989, but these declines appear to have stagnated in the 1990s. The female mortality advantage appears to have been declining over the last 25 years or so.

Table 6 IMR and U5MR by sex, 1970-1994: pooled data

	Infant mortality rate			Under-five mortality rate		
Year	Male	Female	Ratio M:F	Male	Female	Ratio M:F
1970-74	70.4	41.4	1.70	116.3	91.8	1.27
1975-79	71.3	52.1	1.37	116.9	100.6	1.16
1980-84	61.0	54.5	1.12	102.2	93.7	1.09
1985-89	54.4	43.6	1.25	76.1	67.7	1.12
1990-94	55.2	45.3	1.22	76.0	66.0	1.15

Figure 5 IMR and U5MR by sex 1970-1994: pooled data

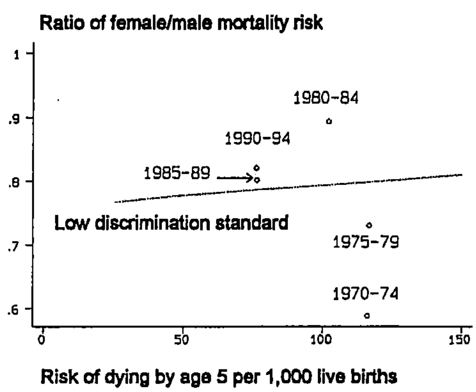


Female children normally experience lower mortality than males. Hill and Upchurch (1995) have developed standard patterns for this female advantage in societies with low gender discrimination. The standard varies with overall level of mortality (measured as male U5MR) and with age (separate standards are developed for IMR, ${}_4q_1$, and U5MR).

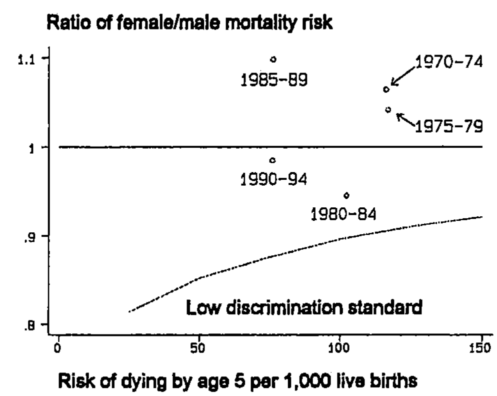
Comparing the Zimbabwean sex differences in mortality with these standards in Figure 6 suggests that in infancy, girls have a mortality advantage over boys similar to that expected in a low discrimination setting. In the age range one to five (panel b), however, all the observations are above the low discrimination standard, and in three time periods (1970-74, 1975-79, and 1985-89) girls actually have higher mortality risks between ages one and five than boys. Overall, girls have rather higher U5MR relative to boys than would be expected (panel c) except for the time period 1970-74, but the differences are not large. The major contributor to this relative female disadvantage is an absolute disadvantage in the age range one to five.

Figure 6 Ratios of female to male IMR, ${}_4q_1$, and U5MR by time period: pooled data

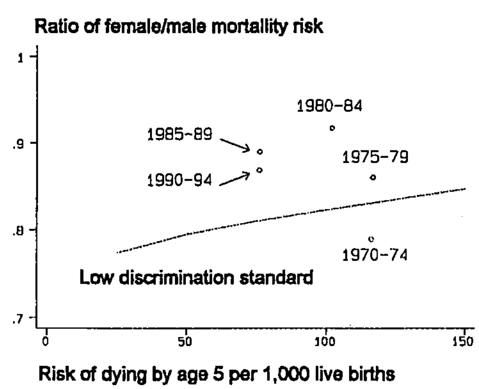
a) IMR



b) ${}_4q_1$



c) U5MR



Multivariate Analysis

The results from the bivariate analyses presented so far suggest that the pace of child mortality decline has varied by time period. Specifically, the 1970s appear to have been a period of stagnant child mortality, the period 1980-87 appears to have been one of rapid decline, and the period since 1988 seems once again to have been characterized by little change. The results also indicate the existence of socioeconomic differentials in child mortality. However, bivariate analysis cannot indicate the relative importance of a number of variables in mortality decline.

Multivariate analysis provides a way to estimate the independent contributions of a range of variables to the behavior of a single dependent variable. The risk of dying by age one is the dependent variable used here. Three analyses, each consisting of four incremental models, were conducted. The first analysis examines trends in infant mortality over time, and the effects of "permanent" characteristics such as education of mother and reproductive dynamics on IMR. Four models are presented. In the first model, only time variables are included. Linear splines are defined for three periods: 1970 to 1979, 1980 to 1987, and 1988 to 1994. The coefficients on these linear splines can be interpreted as the average annual rate of change in IMR during the period. In the second model, education of mother is added to the time variables. In the third model, reproductive dynamics variables are added to the time variables. The reproductive dynamics variables included are: whether the child was a first birth, or a medium-parity (2 to 4) birth after a short (< 24 months) birth interval, or a medium-parity birth after a medium (24 to 47 months) birth interval, or a high-parity (5+) birth after a short, medium, or long (48+ months) birth interval, whether the mother was young (< 20 years) or old (35+ years) at the time of the birth, whether the child was male or female, and whether the child was one of a multiple birth. In the fourth model, time, education, and reproductive dynamics variables are all included. Coefficients for each model of Analysis 1 are shown in Table 7.

Table 7 Logistic regression analysis of time trends in IMR, controlling for mother's education and reproductive dynamics

Variable	Model 1	Model 2	Model 3	Model 4
Time variables				
1970-79	-.013*	-.011	-.008	-.006
1980-87	-.031**	-.026*	-.024*	-.018
1988-94	.016	.028	.032	.045
Mother's education				
Primary		-.340***		-.313***
Secondary		-.561***		-.589***
Reproductive dynamics				
First birth			.158	.202
Parity 2-4, short birth interval			.474**	.478*
Parity 2-4, medium birth interval			.003	-.002
Parity 5+, short birth interval			.979***	.928***
Parity 5+, medium birth interval			-.028	-.075
Parity 5+			-.418*	-.456**
Long birth interval				
Mother < 20 at birth			.271***	.256***
Mother > 35 at birth			.100	.044
Male child			.261***	.260***
Multiple birth			1.418***	1.422***

Significance levels:
*** $p < 0.01$
** $0.01 < p < 0.05$
* $0.05 < p < 0.10$
N = 27,582 births

In Model 1, with only time variables, the period 1970-79 is seen to be one of modest decline (on average) in IMR, at an annual rate of about 1.3 percent per annum, significantly different from zero at the 10 percent level. The rate of decline increased to about 3 percent for the period 1980-87, but the period from 1988 to 1994 showed a small (nonsignificant) annual increase. Adding education of mother in Model 2 reduces the rates of decline or raises the rate of increase slightly, suggesting that improvements in mother's education have been partly responsible for the trends in IMR since 1970. Mother's education itself is highly significant, with some primary education being associated with a 34 percent reduction in IMR, and secondary or higher education being associated with a 56 percent reduction.

Adding reproductive dynamic factors such as parity, birth interval and age at delivery in Model 3 changes the trends slightly more than education; once these factors are controlled, only the period 1980-87 has a significant downward trend in IMR, of about 2.5 percent per annum. Part of the decline in child mortality from 1970 to 1987 was the result of favorable changes in reproductive dynamics during the period and the rate of monthly use since 1988 would have been faster in the absence of continued favorable changes. Among the reproductive dynamic factors, a short birth interval, both for women of medium parity but particularly for women of high parity, is associated with a sharply higher risk, and births to women under 20 also have elevated risks; boys are more likely to die than girls, and children of multiple births are at much higher risk. Rather surprisingly, high parity does not seem to be a risk in and of itself; children born after long intervals to women with four or more preceding births have lower risks than children born after long intervals to women with one to three prior births.

Model 4 combines trend, mother's education and reproductive dynamics. None of the trend variables in this model is significant, although there is still an average decline of about 2 percent per year in the period 1980-87, and an average increase of 4.5 percent in the period 1988-94. The protective effect of primary education is somewhat weakened relative to Model 2, suggesting that part of the effect of primary education is operating through changes in reproductive dynamics. The coefficients on the reproductive dynamics variables change little from Model 3 to Model 4, suggesting little interaction with education.

Model 4 of this analysis suggests that almost all the decline in infant mortality since 1970 has been the result of structural changes in education or reproduction. The increase in IMR since 1988 is probably the result of the HIV/AIDS epidemic. An analysis of the risk of death by age one using per capita GDP (in one model) or rainfall in the previous year (in another model) as the independent variables instead of time itself found no relationship of IMR with GDP per capita (on any lag), and found a weak positive relation with rainfall in the previous year (results not shown). These results suggest that the IMR increase since 1988 was not the result of economic recession or drought.

The second analysis (Table 8) introduces urban-rural residence into the multivariate analysis. Since residence is not a permanent characteristic of a woman or of her children, this variable cannot be used in the long time series since 1970. Instead, analysis has been limited to births in the 60 months before each survey, and a dummy variable for survey (1987-88 or 1994) has been introduced to capture trend. In other respects, the modeling strategy is the same as that used above: the first model includes only dummy variables for residence of the mother at the time of the survey (rural, other urban, Metropolitan) and the dummy variable for survey. The second model adds education of mother, the third adds reproductive dynamics, and the fourth includes both mother's education and reproductive dynamics.

Model 1 shows that children born in rural and other urban areas have much higher risks of dying in infancy than children born in the Metropolitan area (Bulawayo and Harare). There is little difference between rural and other urban areas, however, though other urban areas are slightly more risky than rural. On the face of it, this finding is surprising, since both the standard of living and access to health care can be expected to be higher in other urban areas than in rural areas. The survey (time variable) dummy suggests rising risks from the five years before the 1987-88 survey to the five years before the 1994 survey, though the coefficient is not significant.

Model 2 introduces controls for mother's education. The coefficients of both primary and secondary or higher education are negative, indicating a protective effect, though the primary education dummy is only marginally significant, and the secondary plus coefficient is not significant at 10 percent. The low significance of education relative to the results of Analysis 1 arises in part from the smaller number of observations in the restricted analysis; the magnitude of the primary education effect is much the same as in Analysis 1, though the protective effect associated with secondary or higher education is smaller in the present analysis. The introduction of education variables has little effect on the residence coefficients, indicating that the lower mortality of the Metropolitan area is not primarily the result of differential distributions by education.

Table 8 Logistic regression of differences in IMR by urban-rural residence, controlling for mother's education and reproductive dynamics

Variable	Model 1	Model 2	Model 3	Model 4
Residence				
Rural	.764***	.709***	.785***	.706***
Other urban	.850***	.826***	.819***	.783***
Time trend				
1994 DHS	.136	.155	.159	.190
Mother's education				
Primary		-.300*		-.376**
Secondary		-.307		-.450*
Reproductive dynamics				
First birth			-.090	-.047
Medium parity, short birth interval			-.169	-.164
Medium parity, medium birth interval		-.391	-.398*	
High parity, short birth interval			.568**	.518*
High parity, medium birth interval			-.576**	-.640**
High parity, long birth interval			-.435	-.499*
Mother < 20 at birth			.153	.153
Mother 35+ at birth			.029	-.006
Male child			.142	.144
Multiple birth			1.483***	1.494***

Significance levels:
*** p < 0.01
** 0.01 < p < 0.05
* 0.05 < p < 0.10
N = 5,848 births

Model 3 introduces reproductive dynamic variables. The only major risk factors are high-parity births after a short birth interval and being one of a multiple birth. For medium-parity births, both short and medium birth intervals are associated with reduced risk, a major change from the long-term Analysis 1. High-parity is not a risk factor per se either: both high-parity, medium birth interval and high-parity, long birth interval births have lower risks in infancy than the comparison group, medium-parity, long birth interval births. Controlling for reproductive dynamics has very little effect on the coefficients of residence.

Model 4 introduces mother's education and reproductive dynamics variables together. The coefficients are not dramatically changed: mother's education variables become weakly significant, while the reproductive dynamics variables and residence coefficients are scarcely affected.

Table 9 presents results for the logistic regression of risk of dying in infancy on region of residence of the mother. As in Table 8, region of residence is reported as of the time of the survey. To minimize the effects of changes of residence, only events in the five years before the interview are included in the analysis.

In Model 1, only region of residence and the time trend variable are included. Mortality risks are significantly higher in all three of the primarily rural regions than in the Metropolitan Region. The Northern and Eastern Regions have very similar infant mortality risks, though risks in the Southwestern Region are somewhat lower. Estimates from the 1994 DHS are higher than those from the 1987-88 DHS, suggesting an increase in mortality risks in the recent past.

In Model 2, mother's education is added to the regional variables. Both primary and secondary education are associated with reduced mortality risk, but the effects of secondary education are no larger than those of primary education, and are not significantly different from the risks for women with no education. The inclusion of education has very little effect on the regional differentials or on the trend. In Model 3, reproductive dynamics factors are introduced into the model. The only significant risk factors are being a high-parity birth born after a short birth interval and being one of a multiple birth. The only significant protective factor is being a high-parity birth after a medium birth interval. Including reproductive dynamics variables has virtually no effect on regional or time trend factors.

Table 9 Logistic regression of differences in IMR by region, controlling for mother's education and reproductive dynamics

Variable	Model 1	Model 2	Model 3	Model 4
Region				
Northern	.832***	.786***	.837***	.760***
Southwestern	.625***	.596***	.632***	.585***
Eastern	.849***	.817***	.891***	.834***
Time trend				
1994 DHS	.138	.150	.164	.189
Mother's education				
Primary		-.290*		-.368**
Secondary		-.259		-.409*
Reproductive dynamics				
First birth			-.078	-.049
Medium parity short birth interval			-.157	-.158
Medium parity medium birth interval		-.390	-.399*	
High parity short birth interval			.562**	.511*
High parity medium birth interval			-.585**	-.648**
High parity long birth interval			-.451	-.510
Mother <20 at birth			.147	.152
Mother 35+ at birth			.040	.003
Male child			.142	.144
Multiple birth			1.490***	1.503***

Significance levels:
*** $p < 0.01$
** $0.01 < p < 0.05$
* $0.05 < p < 0.10$
N = 5,848 births

Model 4 combines both mother's education and reproductive dynamics variables. The changes vis-a-vis Models 2 and 3 are slight: once reproductive dynamics are controlled, the education variables become slightly stronger, and once education is controlled, the reproductive dynamics factors also become slightly stronger. This result suggests that a higher level of education is associated with less favorable, rather than more favorable, reproductive dynamics. Controlling for both education and reproductive dynamics has little effect on the regional or time trend variables, suggesting that these two sets of factors have little to do with either the apparent worsening of mortality risks in the late 1980s and early 1990s or the regional differences in mortality risks.

Discussion

The pace of child mortality decline in Zimbabwe since 1970 has been uneven. In the period 1970-79, mortality declined slowly. Then in the period 1980-87, the decline accelerated, only to decelerate again in the period 1988-94. Mother's education and reproductive dynamics factors, particularly short birth intervals and multiple births, have the expected effects on infant mortality: children of better educated mothers have lower risks, while short birth intervals are generally associated with higher risk. Once these two groups of factors—mother's education and reproductive dynamics—are controlled, the pace of child mortality decline in Zimbabwe has been very slow; indeed, the period since 1988 is identified as one of rising underlying risk, if other factors are held constant. If the contribution of the health sector to child mortality decline is identified as (at maximum) that part of the downward trend that cannot be explained by education and reproductive dynamic factors, the contribution is very small.

Residence is strongly associated with child mortality differentials, but the differentials show interesting patterns. Children born in the Metropolitan area (Harare or Bulawayo) have much lower infant mortality risks than children born in either other urban or rural areas, but children born in other urban areas actually have higher risks than those born in rural areas. Little of this excess mortality in smaller towns is explained by differences in education or reproductive dynamics, but may be in part the result of high HIV/AIDS levels in such populations, though the indications from sentinel surveillance data are that differentials in HIV prevalence are unlikely to account for all of it. Other factors contributing to excess infant mortality risks in smaller towns need to be investigated. Among rural areas, the Northern and Eastern Regions have higher mortality risks than the Southwestern Region, with very little of the differentials arising from differences in education or reproductive dynamics.

Conclusions

This paper has examined child mortality trends using data from the 1987-88 and 1994 DHS surveys. Child mortality fluctuated in the 1970s, with probabilities of dying by age five around 10 percent. A period of decline started around 1980, lasting until about 1988. Since that time, mortality has stayed constant or even increased slightly. Bivariate analysis shows lower child mortality for girls than for boys, though the female advantage is somewhat smaller than would be expected in a discrimination-free society. Mortality is very high in other urban areas, which are mostly towns compared to the cities Harare and Bulawayo. Multivariate analysis confirms these main findings. Education of mother is associated with reduced risk, and multiple births, medium-parity births after short birth intervals and high-parity births after short birth intervals are all associated with higher risk. Once these factors are controlled, the underlying trend in childhood mortality is not very satisfactory, showing a slow decline from 1980 to 1988, but a steep rise since 1988.

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Appendix

Probabilities of dying per 1,000 live births

Time period	1987-88 DHS			1994 DHS		
	IMR	$_4q_1$	U5MR	IMR	$_4q_1$	U5MR
1970-71	58.0	38.5	94.3	48.9	58.3	104.4
1972-73	69.5	63.7	128.7	44.2	49.6	91.6
1974-75	53.1	39.0	90.0	71.9	43.3	112.2
1976-77	50.7	37.4	86.2	56.5	51.6	105.2
1978-79	76.1	51.4	123.5	60.8	71.2	127.6
1980-81	57.3	49.9	104.4	70.6	64.7	130.7
1982-83	64.7	33.5	96.1	57.4	41.3	96.4
1984-85	44.3	34.6	77.3	49.2	36.2	83.6
1986-87	47.1	18.0	64.3	42.8	25.5	67.2
1988-89				54.6	23.7	76.9
1990-91				50.6	19.0	68.7
1992-93				49.6	31.8	79.7

Sources: Calculations from 1987-88 and 1994 DHS birth histories