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Preventive Health Strategies and Infant Survival in Zimbabwe*

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Résumé: Il s'agit de l'observation dans une approche multidimensionnelle des variables socio-économiques et démographiques afin d'identifier les facteurs qui influent sur la survie des enfants au Zimbabwe (1983-88) par l'utilisation de données de l'Etude sur la Population et la Santé. Le niveau de participation de la communauté en matière de santé infantile influe de manière conséquente sur la survie des enfants. La principale découverte a été que le niveau moyen d'instruction des femmes en âge de procréation a, dans leur communauté, un impact plus important sur la survie des enfants que celui du niveau d'instruction des mères individuelles. Ce résultat soutient l'argument que la survie des enfants est sérieusement affectée par l'éducation des masses (Caldwell 1989). Cette étude éclaire davantage aussi les théories qui affirment qu'un développement social vulgarisé est nécessaire pour contrer la récente dégradation des moeurs dans les pays en voie de développement (Palloni 1989).

Infant mortality levels are still high in less developed countries today. The major causes of infant mortality are preventable and are tied to decreasing levels of household contamination, increasing nutritional intake and improving preventive and curative health practice (Preston 1980). My objective is to show that these

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inputs affecting infant health can take place on a community level, and additionally, that community-level infant health inputs can sometimes exert an even greater influence on infant survival outcomes than individual-level characteristics.

I examine demographic and socio-economic variables measured at the individual level, as well as community conditions influencing infant survival in Zimbabwe. The theoretical model used shows that the socio-economic status of the household and community conditions are mediated by proximate determinants, including maternal fertility, personal disease control, nutrient availability, and household contamination (Mosley and Chen 1984).

There is not an extensive literature on community level effects on child survival from which to chart theoretical direction for this research (notable exceptions include: Bailey 1988; Mosley and Chen 1984). But there is a developing literature on multi-level analysis (Entwisle 1989; Billy and Moore 1992; Tsui 1985), and an extensive literature supporting the positive effect of the individual mother's education on child survival (Caldwell 1986; Caldwell 1989; Das Gupta 1990; Cleland and van Ginneken 1988; Cleland 1990). In a survey of 99 countries (Caldwell 1986:179) it was found that average levels of female education is the main predictor of child survival at the societal level. There is as close a correlation between child survival and general levels of education in a community as there is between child survival and maternal education (Caldwell 1989:103). A multi-level analysis which incorporates both the individual mother's level of education with the average levels of education of women in the community is necessary to get a better understanding of the relative importance of education at the individual and community level for promoting child health.

Theoretically, this research is motivated by the basic premise stated by Palloni (1985) that economic development and unidimensional health interventions such as immunisation programmes are not enough to ensure constant mortality decline in low-income countries. He suggests that widespread social development is necessary to sustain a consistent mortality decline. There have been not only slowdowns in the pace of mortality decline in African and Latin American countries, but there have even been reversals in infant and child mortality trends in such countries as Zambia (Gaisie, Cross, and Nsemukila 1993:81) and Nigeria (Federal Office of Statistics 1992:78) which are seeing recent increases in child mortality. While medical technology and economic development are important, programmes that ensure the distribution of social development resources throughout the country to improve the living standards of families are necessary to sustain declines in infant mortality. Infant health is chosen as the dependent

variable because infants are the most vulnerable population to the changes in economic and social development (Hill and Palloni 1992).

Further theoretical development is needed on many fronts in order to advance our understanding of determinants of child health. The main analytical difficulty has been in specifying the mechanisms of multi-level models that delineate the pathways by which community characteristics influence individual behaviour (Tienda 1991) and specifying the mechanisms through which maternal education affects child survival (Cleland and van Ginneken 1988). Even less attention has been paid to delineating the mechanisms through which the education of women in the community impacts child health.

Unfortunately, this project does not solve any of those dilemmas. But it contributes to the state of knowledge on the use of multi-level analysis and on the effect of maternal education on child survival by incorporating both level of education of the infant's mother and the level of education in the infant's community into the same model to see which exerts a greater effect on infant survival. While the mechanisms tying community and individual behaviour to child survival are still largely unknown, the average levels of education of child bearing aged women in the community turns out to be a type of proxy for development at the community level. Further research which incorporates participant observation or ethnographic methodology to delineate social networks and spheres of influence within and between networks in a community is necessary to determine the actual mechanisms.

Zimbabwe Social Setting

Zimbabwe is an appropriate social setting in which to look at effects of maternal education on child health because it is a newly independent country in which citizens are exercising a greater sense of political and personal efficacy. The transition in control of educational and health institutions from the hands of colonial settlers who were unconcerned about the health of the majority of the African population to a nascent government elected by the previously dispossessed majority has allowed policy-makers to institute progressive health strategies motivated to benefit the majority populace.

The Zimbabwe government believes that development is not just economic in nature. It is also social, political, and cultural. When assessing their country's development, the people of Zimbabwe chose leadership committed to addressing the relevant questions regarding poverty, unemployment, and inequality. Their concern for social development grew out of their struggle for liberation from colonialism as an expression of their self-determination. The ideological perspective of Zimbabwe's leadership is that market-oriented development does not give preference to the needs of the masses. So the Zimbabwe government

chose not to follow a strategy that measured progress solely by export-oriented economic growth. Instead, they chose to couple economic schemes with social development strategies, and to give priority to the social betterment of the majority of its citizens. This strategy reflects the underlying belief that equitable distribution of resources is an important part of development.

Zimbabwe is an interesting context in which to study child health because of the substantial improvements in indicators of living conditions since political independence (attained April 18, 1980). The country's 1960 infant mortality rate was 113 deaths per 1000 live births; according to the Zimbabwe Demographic and Health Survey (ZDHS), it dropped to 27/1000 (United Nations 1989; ZDHS 1989; Population Reference Bureau 1994). Zimbabwe's Equity in Health programme reflects the government's commitment to social development in many ways. Zimbabwe has encompassed some of the most progressive strategies for improving child health. Some of these include integrating traditional health practitioners into the health care infrastructure, balancing curative and preventive health measures, and a focus on redistributing health services so that the poorest citizens in greatest need have improved access to health services.

The result of the abandonment of the racially discriminatory and inequitable colonial practice in controlling health care access has been overwhelming. There is majority access for Zimbabwe's population to health centres and hospitals in even the remotest areas. During the first 10 years of independence, rural areas were targeted for the more than 500 health centres that were built or upgraded, and more than a dozen district hospitals were completed or are under constructions (World Bank 1992:1). Additionally, between 1980 and 1985, more than 4000 Village Health Workers who disseminate health information and provide preventive and simple curative services in the rural areas were trained. More than 200 State Certified Nurses were trained to manage staff clinics (World Bank 1992:1). The result has been that 'millions of people have for the first time gained access to basic care' (World Bank 1992 : ix).

> In 1980 (at the time that Zimbabwe attained its independence), 44 per cent of the publicly funded services went to the urban-based sophisticated central hospitals serving about 15 per cent of the population, while only 24 per cent went to primary secondary level rural health services for the majority of the population (Sanders and Davies 1988:724).

But as of 1988, 'in Zimbabwe, nearly half of all rural women (were) within 5 kilometres of some type of health provider, and only 12 per cent are more than 15 Km distant from one' (Wilkinson, Njogu, and Abderrahim 1993:24). The median distance to a health centre for married women ages 15 to 49 interviewed in the nationally representative Demographic and Health Survey sample is 3.1. kilometres: 5.1 Km in rural areas and 1 Km in urban areas (Wilkinson, Njogu,

and Abderrahim 1993:26). Immunisation data show no inequality in distribution between rural and urban areas of Zimbabwe (Zimbabwe Central Statistical Office 1989),[1] although there is some inequality by province (Zerai 1992). Additionally, health education has promoted low-risk maternal fertility practices such as delayed child bearing, parities of four or fewer children, and adequate spacing of births (Zimbabwe Federal Office of Statistics 1989).

Multi-Level Approach

By using the multi-level approach, the researcher attempts to guard against the myopia of micro-level analyses which 'implicitly assume that variations in (behaviour associated with the dependent variable) are due only to individual characteristics and that the social context in which people live have invariant effects...' on the outcome variable (Billy and Moore 1992:978). The advantage of the multi-level approach is that the research simultaneously attempts to model the individual-level effects on the outcome variable that macro-level analyses omit. 'A multi-level approach bridges the gap between the strictly macro- and micro-orientations' (Billy and Moore 1992:978).

While the multi-level frameworks have been widely praised for incorporating both micro- and macro-level models (Billy and Moore 1992; Tsui 1985; Brewster, Billy, and Grady 1990; Entwisle, Casterline, and Sayed 1989, etc.), the approach has been criticised for mechanically connecting the individual and contextual models without specifying the mechanisms through which macro forces exert and effect on micro-level behaviour and outcomes (Tienda 1991).

When putting together multi-level models of infant health, the average level of female education is an excellent independent variable to focus on because considerable effort has been expended in an attempt to identify mechanisms linking maternal education to child survival (Caldwell 1986; Caldwell 1989; Cleland and van Ginneken 1988; Mosley and Chen 1984). The problem of specifying the mechanisms organically linking macro and micro influences is exemplified by the problem of specifying the mechanisms through which education affects child health. Whether it is measured at the level of the

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1 According to the ZDHS, among all children 12-23 months, 79.8 per cent living in rural areas had health cards with immunisation data recorded on it and 71.3 per cent of children living in urban areas had health cards. Among children with health cards, 98 per cent received the BCG vaccine in rural areas and 96 per cent received the vaccine in urban areas; 96 per cent of children living in rural areas received their measles vaccine and in rural areas this number was 92 per cent of children ages 12-23 months (Zimbabwe Central Statistical Office 1989:97).

individual woman or measured in aggregate, education is a macro-phenomenon. Formal education prepares the young to fulfil the expectations of their society. Its function is largely socialisation. Unfortunately, although several mechanisms, through which maternal education affects child health, have been proposed in the literature, we still lack a definitive knowledge of these mechanisms (Caldwell 1989:106).

Importance of Maternal Education

A review of the literature shows that while the higher socio-economic status of better educated women explains about half of the magnitude of the relationship between maternal education and child survival (Cleland and van Ginneken 1988), the domestic health practice of individual women is probably the next most salient mechanisms in the maternal education/child mortality relationship.[2] The fact that mother's education is a more important determinant of child survival than father's education shows that there is greater maternal involvement in child-health related care (Caldwell 1989). The mother's education influences her choices and skills in health care practices (Bailey 1988; Das Gupta 1990; Caldwell 1989). For instance, both educated and illiterate mothers recognise when their child is sick but the educated mother more frequently will take action 'without waiting for (her) husband or mother-in-law to notice the child's condition too' (Caldwell 1989:106). 'This is partly because illiterate women do feel a lack of capability when dealing with the modern world' (Caldwell 1989:106). Caldwell found that the educated mother is 'more likely to report back to the health centre if the treatment does not seem to be effecting a cure. Educated women see the (health process) as experimental... (And do not feel it is an attack on the health care practitioner to give this important feedback)' (Caldwell 1989:106). Joshi (1994:24) has postulated that it is through the acquisition of skills and identify that education impacts the health behaviour of women, but says, 'while these findings are interesting, they are still incomplete. More studies, especially longitudinal ones, are needed before these findings can be woven into a meaningful theory'.

Education as a Community Phenomenon

We know even less about the reason average levels of female education in the community exert a positive effect on infant survival. But this is an important

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2 There is supporting evidence for this in a recent article by Arun R. Hoshi 'Maternal schooling and child health: preliminary analysis of the intervening mechanisms in rural Nepal' (1994).

relationship to consider. Caldwell (1989:103) points out that 'an uneducated woman may feel more deprived in a country where most other women are educated than one in which they are not: nevertheless, her children stand a much greater chance of survival'. The mechanisms operating in the mass education/ child mortality relationship are likely to be multi-dimensional. One possibility is health service advocacy. The equitable distribution of community health services influences child health in Kerala State India (Preston 1980). Advocacy to ensure better distribution is imperative. Bailey (1988) found that the shortage of health facilities and personnel affect child health in Sierra Leone. 'As argued powerfully by Caldwell (1986) the key to low mortality at the societal level may be a synergy between mass education and egalitarian politics which leads to demands for a health service that caters to the needs of all' (Cleland and van Ginneken 1988).

Another important possibility is the improvements in status that are accrued to all women as a result of mass education. This impacts how women are viewed in society and also how women view themselves. 'The quality of schooling seems relatively unimportant..., it is not so much what you learn or understand, but how you see yourself and how others see you' (Caldwell 1989:106). 'Women who had been to school thought of the school as part of the whole modern system which included independence, five-year plans, government programmes, health centres, modern medicine and themselves' (Caldwell 1989:106). So mass education has an important influence on both the individual and the society.

Another result of mass education that may have important implications for child survival is its compounding multigenerational effects (Caldwell 1989). Wealth flows reverse as there are larger investments by families in the development of their individual children (Caldwell 1982).

Frameworks

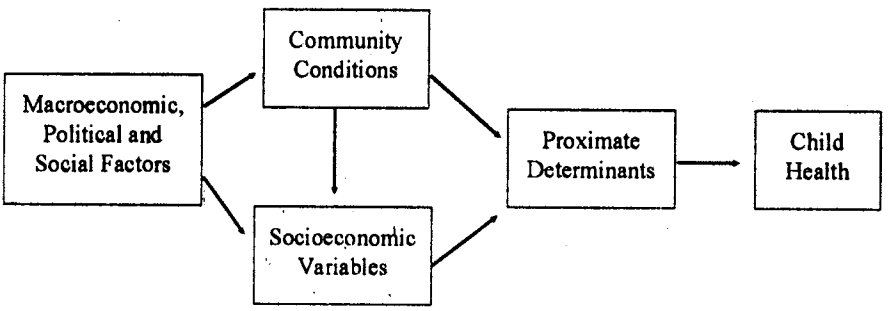
The general theoretical question addressed examines the relationship between development and population. The specific question asks to what extent social development determines infant mortality. There is debate on the causes of mortality decline and the position argued here in that mortality decline is sustained in less developed countries as a result of economic development, humanistic social development, and equitable distribution of development resources (Palloni 1985; Caldwell 1986).

Distribution of development resources to all in society ensures that the standard of living is adequate, women and men have the freedom to choose their contribution to society, and that children's health receives a high priority. Having clean water supplies, proper sanitation, educational facilities, and hospitals, promotes the well-being of citizens which finally has positive effects

on child health. When universal education is encouraged and high percentages of women complete schooling, women have a more egalitarian role in society (Caldwell 1986) that allows them to delay childbearing and encourages the lower parities conducive to improved child health (Chen 1983). When men and women exercise their right to choose their education and employment, living standards rise as a result of increased household economic resources. This produces living environments with reduced contamination that promote child health. Development resources such as piped water and adequate sanitation promote health because they also reduce contamination. Finally, when child health is a high priority in the public sector, as reflected in the building of hospitals and health centres that include prenatal care, immunisation, and growth-monitoring programmes, children's survival chances improve.

The theoretical framework of child health in Zimbabwe here begins with some of the individual-level variables in the classical proximate determinants framework (Mosley and Chen 1984). Other crucial variables that operate through the proximate determinants, such as maternal education, parent's occupation, and community-level variables (see Figure 1) are added. The community conditions are mediated by proximate determinants of child health. Proximate determinants operate through specific mechanisms to determine child health outcomes.

Figure 1: Casual Ordering of Factors Affecting Child Health in Zimbabwe



The casual ordering is that macro-economic, political, and social factors set the stage for community conditions and socio-economic realities in which families find themselves. Community conditions and socio-economic variables operate through the proximate determinants of child health. Community conditions also exert an impact on socio-economic conditions to influence proximate determinants of child health indirectly.

Presently, ***maternal fertility*** variables are typified by later marriage and childbearing, lower parities, and longer birth intervals than in preceding periods in Zimbabwe. Operating through the biological mechanism of improved production of breastmilk and through the social mechanism of less competition with siblings for mother's attention and household resources, children get better nutrition and better care, thus improving their survival chances (Chen 1983).

In Zimbabwe, ***household contamination*** is still a big problem. Piped water is provided to a minority of households. Sanitation measures are still not adequate. But improvements in these areas since independence work through the mechanism of less exposure of children to contamination to make them less susceptible to disease and eventually lower mortality.

Nutrient availability has improved due to drought feeding programmes (Agere 1986), land reform and increased economic opportunities (Sanders and Davies 1988). Operating through the mechanism of decreased susceptibility to illness, improved nutrient availability leads to improvements in child health (Preston 1980).

Personal disease control is typified by better immunisation coverage and increased access to treatment. The goals set by the Ministry of Health of universal immunisation of children and targeting rural areas for building primary health care centres (Manga 1988) have improved the timeliness of disease prevention and treatment. Timely personal disease control is critical for improving child survival chances.

Mother's higher levels of education and increased professional and blue collar ***employment*** of the household head lead to low child-health-risk fertility, timely immunisation of children, adequate nutritional intake by children, and household environments with lessened contaminants. These socio-economic variables operate through the proximate determinants to influence child health.

Community conditions have become more conducive to child health in Zimbabwe today than in the past. Some characteristics include free and compulsory education (Zvobgo 1986), widespread family planning education, land reform measures, free health services to citizens who do not make minimum wage (Sanders and Davies 1988), prenatal care programmes (Agere

1986), and postnatal care including growth monitoring. These conditions make it easier for individual households and mothers to maximise the health of their children.

Community conditions operate through socio-economic variables and proximate determinants to influence child health. For instance, higher percentages of women receiving primary level and more education lead to improved socio-economic outlooks of families, which in turn influence fertility variables, personal disease control, nutrient availability, and household contamination.

Models

The Zimbabwe Demographic and Health Survey (ZDHS) and ZDHS Service Availability data are used to analyse the effect of individual and community-level determinants on child mortality between 1983 and 1988 in Zimbabwe. To incorporate individual level and contextual determinants in this study of infant health in Zimbabwe, a three-tiered analysis is conducted by establishing a baseline model that includes individual-level determinants and background characteristics and then analysing both a community model that includes distal determinants and finally an expanded model that incorporates all the variables in the first two models. (See Figure 2).

First, the individual level risk factors to neo-natal and post-neonatal survival are evaluated for children born during 1983-1988 in Zimbabwe. Background variables are added as controls. The maternal histories collected in the Zimbabwe Demographic and Health Surveys provide adequate data to examine effects of environmental contamination and maternal variables on individual-level child survival.[3] However, to understand child health status better, it is important to understand the context in which child health outcomes unfold. This analysis reveals that individual level risk factors are expectedly not the whole picture, but mediate contextual determinants.

In the second part of the analysis, the effect of resource distributive programmes (as reflected in contextual variables) are examined. These programmes were established after Zimbabwe attained independence. The expanded model examines the joint effects of the individual-level determinants and community conditions on neonatal and post-neonatal mortality.

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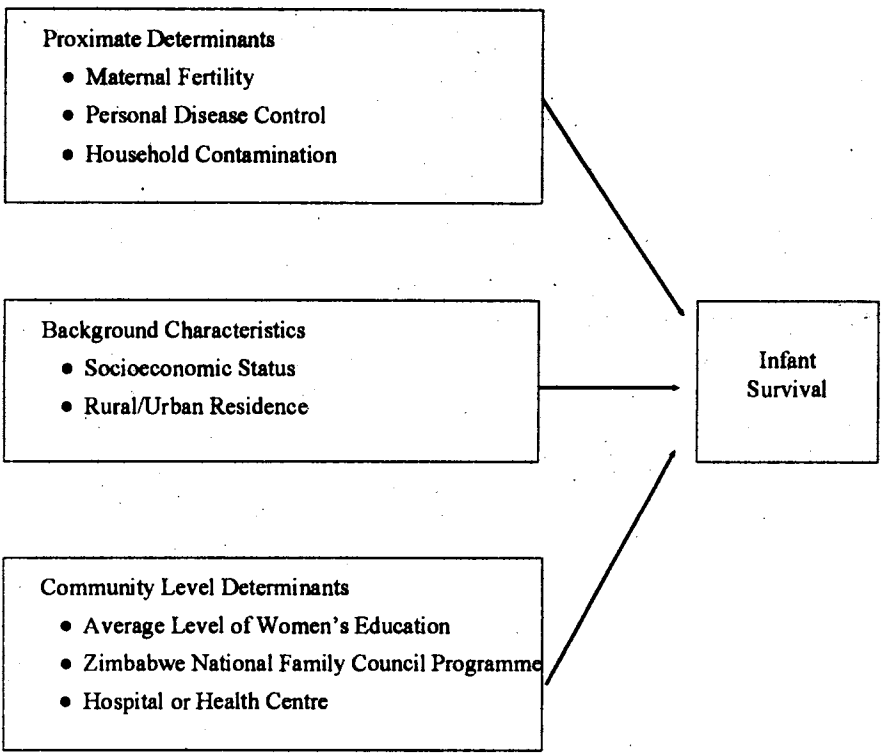
3 Values of socio-economic variables collected at the time of the survey are used as a proxy for socio-economic measures at the time the child was exposed to risk.

Figure 2: Proximate and Distal Determinants of Survival for Infants Born Between 1983 and 1988 in Zimbabwe



Note: Model 1 includes proximate determinants and background characteristics.
Model 2 contains distant determinants.
Model 3 includes proximate, background, and distal determinants.

Data

The Demographic and Health Surveys (DHS) are a rich source of data on developing countries in general, and Africa in particular. The national probability surveys interview all or ever-married women ages 15-49 and provide a wealth of information on child health, the proximate determinants of fertility, fertility preferences, and other social and economic characteristics unmatched by comparative data from developing countries to date.[4] Retrospective data are collected to provide complete birth histories, as well as more detailed information on the five years preceding the survey (1983-88).

The sample size in the Zimbabwe Demographic and Health Survey is 4,201 women. It was fielded between June and September 1988. To prepare the data for analysis, files with mothers, children, and finally child-months as three different units of observation from the ZDHS data set were constructed. While the ZDHS data give very specific information on 1983-88 they only give limited birth history and child mortality information for previous years. Therefore, the empirical analyses here are restricted to the 3,393 children born during this short period.

Variables analysed for all models are listed in Table 1. Descriptive statistics for all variables are listed in Table 2. The analysis of child survival is limited to infants under 1 year where a majority of child mortality usually occurs. That infant mortality rates are sensitive to social development inputs permits an assessment of the impact of proximate and distal determinants on child health in Zimbabwe. Different sets of variables influence neonatal and post-neonatal mortality, requiring separate investigations for the latter. Analysis of neonatal and post-neonatal survival allows examinations of two important aspects of early

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4 Some of the limitations of the Demographic and Health Survey data set pointed out by Brockerhoff and De Rose (1944) that need to be acknowledged include the fact that there is no information on childrearing history. This analysis assumes that all children live with their birth mothers. Another limitation is that there is insufficient observation of morbidity and health interventions — educated mothers are more likely to report health interventions. The result in this analysis is that the effect of prenatal care is possibly underestimated. Finally, there are at least two instances in which the effect of educational levels on infant survival might be underestimated. Because the birth history data are collected retrospectively and mothers with greater levels of education are probably less likely to omit births that end in death than are mothers with less education, the effect of education on infant survival may be underestimated. And because maternal education is related to maternal mortality, and birth history information is not collected on mothers who died in the locale, the effect of education on infant survival might again be underestimated.

child health in Zimbabwe; neonatal mortality reflects 'the pre-existing health conditions of the mother and the health care she and her infant received during pregnancy and shortly after delivery' and post-neonatal mortality reflects 'post-birth socio-economic, environmental, and medical care' indicators (Campbell 1989).

Proximate Determinants

The study uses individual-level variables whose relationship to infant survival has been well established (Chen 1983; Mosley and Chen 1984; Pebley and Millman 1986; Curtis, Diamons, and McDonald 1993; Phuapradit *et al* 1990). Mother's age at childbearing, parity, and the preceding birth interval are examined in the form of a high risk fertility index. If any of these high risk conditions existed at the time of the birth, a pregnancy was deemed to be at high risk of complications, negative birth outcomes such as neo-natal mortality, or problems with post neo-natal survival. If none of the conditions existed, the index child was designated a low risk birth category.[5] Half (51 per cent) of children in the subsample were born in conditions of high risk to pregnancy, birth or postbirth complications. The high-risk maternal and child health index was constructed to address the problem of collinearity among maternal fertility variables and also in preparation for further bivariate analysis which will treat risk as endogenous to the relationship between background and community variables affecting infant survival.

Other variables from the classical proximate determinants model such as nutrient availability, personal disease control, and incidence of injury were not examined because of insufficient information on the variable itself (in the case of incidence of injury for all infants and immunisation or other indicators of personal disease control for infants that died), and inadequate information that would allow causal inference (such as nutrient availability and succeeding birth intervals).

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5 The combined index more closely aligns this analysis with policy prescriptives that identify high risk pregnancies than with theoretical concerns with the distinctive impact of fertility limitation, birth spacing, and maternal age on infant survival.

Table 1: Variable Names and Values for all Models

Variable Type and Name	Description	Value
Dependent Variables		
Neo-natal mortality	Mortality before completing first month of life	1 = Died, 0 = Survived
Postneo-natal mortality	Time varying: Mortality after surviving the first month and before completing the 1st year of life	1 = Child died in observation month, 0 = Child survived the observation month
Independent Variables		
1. High-risk maternal fertility index	Index accounting for the presence of at least one high risk variable:Parity greater than 4; Insufficient preceding birth interval: interval of <24 months for second or higher parity child; or Maternal age under 18 or over 36.	1 = At least one high risk factor 0 = None
Socioeconomic Status		
Educational level of mother	Recoded to 3 dummy variables	
2. Incomplete primary	(omitted category)	1 = yes, 0 = no
3. Complete primary		1 = yes, 0 = no
4. Secondary		1 = yes, 0 = no
Parent's usual occupation	Father's occupation measured: mother's occupation substituted if father is unemployed or absent.	
5. Missing	Father's and mother's occupational data missing	1) yes, 0 = no
6. None	Parent has no usual occupation	1 = yes, 0 = no
7. Agriculture	Includes farmworkers and farmers	1 = yes, 0 = no
8. Manual labour	Non-agricultural	1 = yes, 0 = no
9. Non-manual labour	(omitted category)	
Household Contamination		
10. Household contamination factor	Factor score coefficient comprised presence of refrigerator in household; toilet on premises, porous floor material; and distance to household water supply (ordinal codes: 1 = on premises, 2 = less than 5 metres from premises, 3 = 6 to 100 metres away, 5 = 101 to 500 metres away, 6 = 501 metres to 1 km away, 7 = 1-3 kilometres away, 8 = 3-5 kilometres away, to 9 = greater than 5 kilometres away)	mean = 0; s.d. = 1
	Number at time to survey	
11. Number of household members	Care from a medical professional	Continuous
12. Prenatal care	Place of residence	1 = yes, 0 = no
13. Residence		1 = urban, 0 = rural
Community Conditions	Ordinal variable recoded to three dichotomous variables	
Average level of females' education in the community	(omitted category)	
14. Incomplete primary		1 = incomplete primary
15. Complete primary		1 = complete primary
16. Secondary education		1 = secondary
17. ZNFPC community based distribution programme		1 = yes, 0 = no
18. Hospital or health centre in the community		1 = yes, 0 = no

Source: ZDHS data (1989).

Table 2: Descriptive Statistics on all Variables in Models

Variables	N	Mean	Standard Deviation
Neo-natal mortality	3393	0.03	0.14
Postneo-natal mortality	3223	0.02	0.14
Proximate Variables			
1. High risk fertility	3390	0.51	0.50
2. Mother under age 18	3393	0.04	0.19
3. (Mother 18-36)	3393	0.82	0.38
4. Mother over age 36	3393	0.14	0.35
5. Preceding birth interval < 24 months	3388	0.19	0.39
6. Birth order > 4	3393	0.36	0.48
7. Number of household members	3393	7.41	3.37
8. Professional prenatal care	3393	0.84	0.37
Background Characteristics			
9. (Mother did not complete primary level education)	3393	0.19	0.39
10. Mother completed a primary level education	3393	0.63	0.48
11. Mother completed secondary level or more education	3393	0.18	0.38
12. Parents unemployed	3393	0.02	0.14
13. Agricultural occupation	3393	0.26	0.44
14. Manual occupation	3393	0.50	0.50
15. (Non-manual occupation)	3393	0.17	0.38
16. Missing information on occupation	3393	0.05	0.22
Type of Place of Residence			
17. Rural/urban residence	3393	0.27	0.44
Community Conditions			
Average level of females' education in the community:			
18. (Incomplete primary)	3393	0.04	0.19
19. Complete primary	3393	0.82	0.38
20. Secondary education	3393	0.14	0.35
21. ZNFPC distribution programme in locale	3387	0.66	0.47
22. Hospital or health centre in the community	3387	0.81	0.39

Source: ZDHS data (1989)

Note: Residual categories in parentheses.

Background Characteristics

Socio-economic variables determine the availability of nutritional resources, which is especially important because once infants reach the age of 6 months, they can no longer depend on nourishment from breastmilk alone. Mother's education is important because it facilitates her integration into a society impacted by traditional customs, colonialism, and neo-colonialism. Education heightens her ability to make use of government and private health care resources and it may also increase the autonomy necessary to advocate for her child in the household and the outer world. If a mother has not completed primary level education, her child is more likely to die.

The other socio-economic variable measured is parent's occupation. If parents do not have regular employment, they will be less able to supply nutritional needs of children and consequently their children will be more susceptible to disease and other causes of death.

Household contamination is an important indicator of child susceptibility to contagion leading to disease. The higher the value of the household contamination index, the greater the contamination in the household through lack of easy access to water, modern toilet facilities, and refrigeration and having nonporous floor material. A factor score was constructed for these variables to address statistical problems presented by the level of high collinearity among them. The number of people in the household is added as a measure of crowding in the household. Finally rural/urban residence of the infant is included model as a control variable.

Distal Determinants

The ZDHS-Service Availability (ZDHS-SA) data set was collected on 166 of 167 sample clusters[6] in Zimbabwe. ZDHS-SA variables were matched to the individual-level and child-month working files by cluster. Two of the variables for examining the effect of community-level variables on infant survival between 1983 and 1988 are extracted from the ZDHS-SA. General categories of variables measuring community-level inputs into child health include existence of family planning education and contraceptive distribution programmes, female education, and health care availability.[7]

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6 Often these clusters were located in independent communities.

7 Since information collected on community health facilities within the Zimbabwe Demographic and Health Survey consisted of data from only the *nearest* health facility, these data are not nationally representative.

Clusters are the primary sampling unit used in the ZDHS. Families living in the same cluster live in close proximity to each other in the same community. In the sample of 3,393 children, an average of 20 survey households is represented by each cluster (with a standard deviation of 11). This ranges from 1 to 84 of the households in which women were interviewed. The total number of households in a cluster is less than 500 for a majority (72 per cent) of the communities and no more than 2000 for all communities (Wilkinson, Njogu, and Abderrahim 1993).

The first community-level variable of interest is the average level of women's education. A variable indicating the mean level of education for childbearing aged women was created by calculating average educational levels of all women by cluster from the original ZDHS file. Caldwell (1986:191) points out that the percentage of women in the community with primary schooling is an important determinant of child health because it indicates female autonomy and the extent of egalitarianism in the society. The more empowered childbearing-aged women are as a group, the more likely individual women in that community will be able to promote actively the health of their children. Children living in communities where women on the average complete primary and secondary level education are expected to have higher probabilities of survival than those living in communities in which women on the average do not complete primary-level education.

The second community-level variable is whether or not the locale has family planning education and contraceptive distribution programmes which are important because it is hypothesised to increase the likelihood that parents use contraceptive at least to space their births, to the benefit of mother and child's health. Children who live in a community in which family planning education and contraceptive distribution programmes are available, are more likely to be healthy.

The availability of community health care facilities indicates the extent of health services, including prenatal and postnatal care, immunisation, and growth monitoring. Hospital and clinic availability is mainly important for personal disease control. If resources for disease prevention, such as prenatal care, immunisation, and growth monitoring are available in the community, the child is more likely to be healthy. If resources for disease diagnosis and treatment, such as hospitals, health clinics, and health workers are available, the child is more likely to survive.

In Zimbabwe, most hospitals and health clinics have prenatal care, immunisation, and growth monitoring. Availability of hospitals and health centres in the community is also an indicator of social development. The greater the development infrastructure, the greater the access to hospitals and other health resources.

Methods

The logistic regression and Cox proportional hazards models are used to estimate the effect of proximate and distal covariates on child mortality. Neo-natal mortality models are estimated with logistic regression. Post-neonatal mortality models are estimated with the proportional hazards model. The Cox proportional hazards model allows researchers to study events, or the change from one state to the other at a specific point in time (Allison 1984). For the first part of this analysis the transition from the state of being alive to the state of death is examined.

Results

The model selection results appear in Table 3. The overall fit for all neo-natal and post-neonatal mortality models is good. The chi-square statistic is significant at the 001 level for proximate, community and saturated models. Chi-square tests result in significant improvements of the expanded models over the proximate and community models. This shows that individual and community-level variables contribute significantly to our understanding of infant mortality in Zimbabwe.

Table 3: Mortality Model Selection

Model	Overall Model Significance	-2* Log Likelihood	Degree of Freedom	Chi-square (Comparing Constrained and Saturated Models)
Neo-natal mortality:				
Base (proximate model)	82.86***	1450.38	4	9.90•
Community model	23.86***	1517.92	10	77.44***
Expanded (saturated model)	95.41***	1440.48	-	--
Postneo-natal mortality:				
Base (proximate model)	544.41***	12618.82	4	128.34***
Community model	278.19***	12883.52	10	393.04***
Expanded (saturated model)	669.70***	12490.48	-	---

Source: ZDHS data (1989)

Note: Negative log likelihoods are reported in Tables 4 and 5.

Tables 4 and 5 list the results of the logistic regression and Cox regression analyses of neonatal and post-neonatal mortality, respectively. Odds ratios are presented for all logic models, and hazard ratios are presented for Cox regression models. Estimated hazard and odds ratios are relative risks — for a one-unit change in the independent variable the instantaneous risk of death increases by a multiplicative factor of the reported value of the hazard ratio (Computing Resource Centre 1992:212). The first column in Tables 4 and 5 list the independent variables for all three models. The second and third columns list the results of the individual-level model, the fourth and fifth columns show the results of the community model, and the sixth and seventh columns report the results of the saturated model.

Determinants of Neonatal Mortality

All children at risk of dying before the first completed month of life are included. Of the 3,393 children in the sample, 108 infants did not survive to age 1 month (a neo-natal mortality rate of 32.1 deaths per 1000 live births). Proximate and background variables that determine whether a child survives to age 1 month are listed in Table 4.

The high-risk maternal fertility index is the first significant determinant of neo-natal mortality ($\alpha = 0.05$). If the child's birth order is greater than 4, if the child's preceding birth interval is 24 months or greater, or if the mother was not the optimal age at birth, as indicated by a value of 1 on the high-risk index, the child is 1.42 times as likely to die as infants who were born under low risk conditions. A low risk birth is one in which the child has higher chances of survival because there has been a sufficiently lengthy time interval after the previous birth (or because the index birth is a first order birth), the mother is at her biologically and socially optimal age for childbearing, and because of lessened competition for maternal resources due to lower parities.

The only significant household contamination variable is the number of persons residing in the household. For each additional member in the household, children are only 89 per cent as likely to die in the first month of life as children in smaller households ($\alpha = 0.001$). Whereas, originally, theory predicted that the number of people in the household could be used as a proxy for crowding and increased susceptibility to disease through contagion (Aaby 1988); it appears the number of household members may be a better proxy for the number of caretakers available to children under 5 years of age. As shown in Table 6.

Table 4: Determinants of Neo-natal Mortality

Variables	Individual model		Community model		Saturated model	
	Odds / Ratio	Z / Value	Odds / Ratio	Z / Value	Odds / Ratio	Z / Value
Proximate Variables						
1. High risk maternal fertility	1.42*	2.246			1.42*	2.170
2 Number of household members	0.89***	-4.430			0.89***	-4.227
3 Household contamination factor	0.89	-0.953			0.88	-0.978
4 Professional prenatal care	0.35***	-6.591			0.35***	-6.596
Background Variables						
5. Mother completed secondary or more education	0.73	-1.082			0.86	-0.496
6. Mother completed primary level education	0.89	-0.659			1.02	0.086
7. (Mother did not complete primary level education)						
8 Parents unemployed	2.79*	2.388			2.85*	2.426
9 Agricultural	1.11	0.391			1.09	0.317
10 Manual	1.00	0.035			1.00	0.018
11 Missing	1.73	1.499			1.69	1.330
12 (Non-manual)						
13 Rural/urban residence	0.53*	-2.497	0.62*	-2.063	0.54*	-2.165
Community Variables						
14 Secondary level education			0.33*	-2.715	0.41*	-2.022
15 Completed primary level education			0.49**	-2.568	0.58	-1.737
16 (Incomplete primary level education)						
17 ZNFPC distribution programme in locale			0.76	-1.697	0.73	-1.846
18. Community hospital or health centre			0.97	-0.169	1.04	0.243

Source: ZDHS data (1989)

Notes: Logistic regression analysis of neonatal mortality, * p <.05, ** p <.01, and *** p <.001.

Omitted category in parentheses.

Table 5: Determinants of Post-neonatal Mortality

Variables	Individual model		Community model		Saturated model	
	Hazard / Ratio	Z / Value	Hazard / Ratio	Z / Value	Hazard / Ratio	Z / Value
Proximate Variables						
1. High risk maternal fertility	1.10	1.268			1.08	0.991
2. Number of household members	0.86***	-10.973			0.87***	10.380
3. Household contamination factor	1.02	-0.330			0.99	-0.208
4. Professional prenatal care	0.30***	-16.483			0.31***	-16.222
Background Variables						
5. Mother completed secondary or more education	0.49***				0.71	-2.096
6. Mother completed primary level education		-4.517				
7. (Mother did not complete primary level education)	0.84	-2.031				
8. Parents unemployed					1.80*	2.791
9. Agricultural					0.85	-1.365
10. Manual	1.74**	2.639			0.85	-1.433
11. Missing	0.92	-0.720			1.33	1.528
12. (Non-manual)	0.90	-0.959				
13. Rural/urban residence	1.50*	2.206	0.62***		0.54*	-4.254
Community Variables	0.41***			-4.044		
14. Secondary level education					0.11***	-7.962
15. Completed primary level education		-6.553			0.45***	-6.122
16. (Incomplete primary level education)			0.08***	-9.284		
17. ZNFPC distribution programme in locale			0.38***		0.72***	-4.102
18. Community hospital or health centre				-8.274	0.74***	-3.729

Source: ZDHS data (1989)

Notes: Logistic regression analysis of neonatal mortality, * p <.05, ** p <.01, and *** p <.001.

Omitted category in parentheses.

Table 6: Household Composition by Household Size

	ALL Households (n = 2228)	Number of People in Household	
		Six of Fewer (n = 1035)	More than Six (n = 1193)
Average number of children under age 5 in household	1.81	1.36	2.20
Average number of children born to index mother 1983-88	1.52	1.47	1.57
Percentage of households with children born between 1983 and 1988 not residing in household	17.00	24.20	10.70
Percentage of households with children under age 5 in addition to those born between 1983 and 1988	32.40	16.60	46.20
Average number of members over age 5	5.49	3.23	7.45
Average number of eligible women in household	2.00	1.00	2.00
Average household size	7.30	4.59	9.66

Source: ZDHS data (1989).

The main compositional difference between large and small households is that larger households contain greater numbers of adults. This finding supports the idea that these additional members contribute to the pool of caretakers or free the primary caretaker to spend more time with the new-born.

Personal disease control is measured by whether or not the pregnant mother was cared for by a nurse or doctor prior to the birth of her child. New-borns whose mothers received prenatal care from a health professional are 35 per cent less likely to die as those whose parents had not obtained prenatal care from a nurse or doctor ($\alpha = 0.0011$).

Neonates whose parents are unemployed are 2.79 times as likely to die during the first month of life as children whose parents are working in professional occupations. This variable indicates socio-economic resources of the household. Households that can afford to provide proper nutrition, personal disease control,

and highly sanitary living environments are more likely to have healthy children residing in them.

The last variable in the individual-level model is rural/urban residence. New-borns in urban areas are approximately half as likely to die as new-borns living in rural areas during the first month of life ($\alpha = 0.05$). Conditions are still more favourable to child health in urban areas of Zimbabwe.

Logistic regression analysis of the effects of community-level variables on neo-natal mortality are reported in columns 4 and 5 of Table 4.[8] The average educational level of women in the community significantly influences survival of new-borns. Infants living in communities where women have a secondary level education are 0.33 times as likely to die and those living in communities where women have on the average completed a primary level education are 0.49 times as likely to die the first month of life, as infants living in communities where the average woman is uneducated. Both results are highly statistically significant ($\alpha = 0.01$).

The only shared variable in the proximate model and community model is rural/urban residence. Similar to the residence variable in the individual model, urban neonates are 0.62 as likely to die as rural neo-nates.

Model 3 encompasses the individual level variables in model 1 and community-level variables of model 2 (see columns 6 and 7 of Table 4). The magnitude and direction of effects are the same as in the results for the constrained individual and community models. The significance is virtually the same as well.

Determinants of Post-neonatal Survival

Determinants of infant survival to age 1 year are examined (see Table 5) using Cox regression. Of the original 3,393 children observed, 108 were deleted because they died in the first month of life, and 62 observations were deleted because they were censored.[9] Of the 3,223 children at risk, 68 did not survive to 12 months of age (a post-neonatal mortality rate of 23.2 deaths per 1000 live

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8 My assumptions for analysis of multi-level models include the following: that contextual variables are not picking up effects of correlated, excluded individual-level variables; that mothers have not selected their contexts by perceived levels of education, existence of contraceptive distribution programmes, or access to health facilities; and that mothers' community of residence at the time of the survey are where the children were exposed to the risk of mortality in earlier years.

9 These children were less than 1 month old because they were born during the month the survey was taken.

births). The independent variables are the same as in the analysis of neo-natal mortality.

The significant household influence on infant mortality was the number of members in the household. For each additional member in the household, children were only 86 per cent as likely to die before reaching age one as children living in households with fewer members (α = 0.001). The more household members there were, the more likely the infant to survive. The magnitude of the effect is similar to that in the neonatal mortality model.

Infants whose mothers obtained professional prenatal care were 0.30 times as likely to die in Zimbabwe as infants whose mothers had not obtained such care. This statistic is significant at the α = 0.001 level.

Family-level socio-economic variables are important for infant survival. Mother's education (at least primary level) and parents' employment status significantly influence survival of infants. Infants whose mother had a secondary level education were 0.49 times as likely to die (α = 0.001) and infants whose mother completed primary level education were only 0.84 times as likely to die, as infants whose mothers did not complete a primary level education (α = 0.05). While mother's individual-level education was not significant in neonatal mortality models, it was significant in infant mortality models. In the individual-level post-neonatal model, neither parent has a regular occupation, the infants were 1.74 times as likely to die as children whose parents work in non-manual (including professional) occupations (α = 0.01).

According to individual level mode results, infants living in urban areas are 0.41 times as likely to die as infants living in rural areas (α = 0.001). And according to results from the community model, infants living in urban areas are 0.62 times as likely to die as those living in rural areas (α = 0.001).

Results from the community model reveal that in Zimbabwe infants living in communities where adult female educational attainment is on the average primary or secondary level are 0.38 and 0.08 times as likely to die as infants living in communities where women are largely uneducated (α = 0.001). Infants living in communities with Zimbabwe National Family Planning Council (ZNFPC) contraceptive distribution programmes were 0.76 times as likely to die as those without this resource in their communities (α = 0.001); and those living in communities with access to hospitals or health centres are 0.66 times as likely to die within the first year of life as those that do not have access to modern health care (α = 0.001).

There are some differences between the results of neo-natal and post neo-natal mortality community models. ZNFPC and hospitals or health care centres in the community do not significantly influence neonatal mortality. This social

determinant is less important for neo-natal survival than biological determinants influencing fetal health. But the average level of adult female education in the community is important in both neo-natal and post neo-natal mortality models.

Results from the expanded model reveal that the number of people in the household, professionally administrated prenatal care, mother's secondary level education, parent's regular employment, urban versus rural residence, the average level of women's education in the community, ZNFPC contraceptive distribution programmes and hospitals and health centres in the community all significantly influence infant survival (Table 5). The magnitudes of effects are similar to the proximate model of individual-level family and household variables. The main difference is that education of individual mothers is a weaker determinant of post-neonatal mortality in the saturated model. Whereas maternal secondary level education was a strong determinant of child survival in the model that excluded community variables, once community variables are added in a saturated model, the average level of female education in the community overshadows the effect of maternal education on infant survival. Among neonates, the effect of individual mother's education in the saturated model is not significant in either the individual-level or saturated model, although the level of education of women in the community is a significant determinant of neonatal survival (refer to Table 4).

Discussion

The individual-level model effectively sets the stage for results to follow in the community and expanded models. Its performance is supported by the chi-square statistics in Table 3 which report that the community model is improved by the addition of proximate and background variables. The proximate determinants framework yields some useful predictors, but not all variables significantly influenced neo-natal and post neo-natal mortality in Zimbabwe.

Individual-level variables that are consistently significant predictors of child survival include the number of members in the household, whether the mother obtained prenatal care from a doctor or nurse and parents' employment. The household contamination variables did not yield significant results as was expected. Household contamination, as measured by a factor of porous floor material, refrigerators, distance to household water, and modern toilet facilities, is not an important indicator of new-borns' and infants' health status once other socio-economic variables are taken into account. And although the number of household members was an important indicator in all four models in which its effect was estimated, it operated less as a crowding and increased contagion variable and more as a possible childcare variable.

As was expected, community-level variables gave added explanatory power to the individual-level models. High proportions of women receiving a secondary level education in the community was the most important community-level variable influencing infant mortality, with access to hospitals and the existence of ZNFPC programmes being important as significant determinants of post-neo-natal survival.

Educational levels of women in the infant's community proved to be more significant than the education of an infant's own mother in neonatal and post-neonatal models that include both variables. This indicates that equitable distribution of this resource is beneficial to infant and new-born survival (Caldwell 1986). The proportion of young girls enrolled in primary school has declined in most African countries since the 1980s (according to the World Bank and UNICEF), and will probably decline further in coming years. The positive relationship between mass schooling and infant survival will translate into lower infant mortality in Zimbabwe only insofar as the country's population and economic growth levels allow for increased enrolment.

Conclusion

While a clear delineation of the mechanisms linking education and infant survival still remains an unresolved issue, results of this analysis show that secondary-level education of individual mothers and of women in the community promotes child survival. Results reveal that when maternal education and average levels of female education in the community are both observed, the state of female educational advancement (or lack of education) in the community overshadows the effect of the individual mother's educational attainment on infant survival. It is not clear what the average level of female education in the community is actually measuring. At least, it measures the existence of a phenomenon at the contextual level which exerts an effect on infant mortality. We need to do further research to help us more specifically define this context in social terms (and not just as an area demarcated by a specific geopolitical boundary) and then examine specifically what characteristics of this context correlate to proximate causes of health behaviour and outcomes. Is it that uneducated women are mimicking the health promoting behaviour of educated women who live close to them? Or are women who live in close proximity sharing child care information? Another possibility is that there is a greater demand for social amenities that benefit child health and that all benefit regardless of educational level. Ethnographic child care practice studies are needed to get a better grasp of these mechanisms (Feyisetan 1988).

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