Working full paper

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Trends and determinants of childhood mortality in rural South Africa: What can it tell us about the impact of government programs?

Background

Global trends throughout the 1970's and 1980's have shown substantial declines in childhood mortality. The decline has been attributed to improvements in a range of factors known to impact on child health such as improvements in nutrition, housing conditions, environmental conditions and development of health services and factors related to socioeconomic conditions.

Many countries in sub-Saharan Africa experienced reversals in the trend during the 1990's whereby part of the increase has been attributed to mother to child transmission. Studies investigating the reversal of trend, have attributed these changes to changes in a wide range of determinants that are known to impact on child survival such as fertility behaviour, nutritional status, maternal and child health, environmental health factors and socioeconomic factors related to household conditions and maternal education.

South Africa is one of the countries in the southern Africa region that has witnessed reversals in the gains made in child mortality since about 1992. While South Africa experienced major social changes including considerable restructuring of the health system prior to and during this period much of the increase in childhood mortality has been attributed to the mother to child transmission.

Wagstaff (2004) and others have highlighted the inequalities in child mortality generated by conditions of poverty and point out the importance to focus attention on the role that government programs play in reducing child mortality.

Application in South Africa

Post 1994, South Africa has introduced far reaching programs making it important to grapple with this question and their role with poverty. To date there is little information of how improvements in social and economic factors have influenced the underlying determinants that act through the more proximate determinants of child mortality.

Analysis of the 1998 South African Demographic and Health Survey has shown that there are major population group differences whereby African neonates are 3 times more likely to die that white neonates. There is an increased risk with age, where African children over 1 month have a 6 times greater mortality risk than non-white children and only some of this differential is accounted for by metro/non-metro residence or mother's education. This suggests that conditions of poverty have a greater effect after the neonatal period.

Provincial data of the trends and differentials from a basic descriptive analysis of the 1998 DHS data for African children in Kwa-Zulu Natal, without adjusting for the effects of other associated covariates show the greatest mortality difference between the two poorest quintiles.

Focusing on the trends and differentials in KZN, a basic descriptive analysis of the 1998 DHS data for African children in KZN, without adjusting for the effects of other associated covariates show the greatest mortality difference between the two poorest quintiles. Linking the Africa Centre Demographic Information Surveillance Area (ACDIS) birth history data with socioeconomic status data as measured in the form of household assets did not account for such substantial differences in a regression analysis, suggesting that the 40% of people represented in the poorest quintiles in the DHS is quite a homogeneous group within the ACDIS area. Second, the retrospective ACDIS trend shows that substantial declines in childhood mortality during the 1980's were experienced by children aged 1-4 as well as the post-neonatal period. The reversals that began in the early 1990's were most pronounced in the post-neonates. Third, the model building process shows that while there is variation in mortality associated with household wealth measured by household assets, more of the mortality differential is accounted for by water, sanitation and mother's education, but it is not clear that water and sanitation play a role or if of these factors are acting as a proxy for an urban/rural gradient in the area which may result in access to other resources.

Aim

The Africa Centre Demographic and Information Surveillance Area has been under surveillance since 2000, a period during which several government programs have been implemented. The prospective data provide a unique opportunity to investigate the role that government programs have had on child mortality and what age groups are particularly sensitive to conditions of poverty amongst a relatively homogeneous rural population. A possible working framework which incorporates HIV will be developed to conceptualise the relationships between programs, other determinants of child health and mortality.

Methods

Retrospective birth histories from 1981-2000 were used to estimate level and trend of the indicies of childhood mortality. Period life table measures of mortality were calculated from the data for single years prior to the dates of interview using lifetable methodology.

An event history file was constructed for the Poisson regression models. The data file is structured as an aggregated data file for children born the 20 year period prior to the date of the mother's interview. Each child's exposure time from birth until interview or the point of death is divided up by age and then summed across all children sharing a common set of characteristics. Poisson regression is used to fit a regression model to the log of the rate calculated as the number of deaths divided by exposure time:

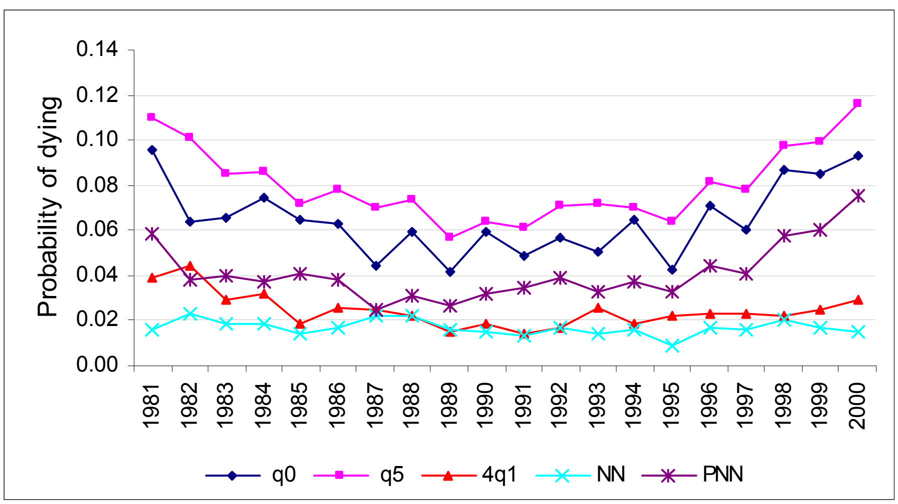
$$\ln(d_{ij} / PYO_{ij}) = \ln(d_{ij}) - \ln(PYO_{ij}) = \beta_0 + \beta_1 X_{\mathrm{i}} + \beta_2 X_{1j} + \beta_3 X_{2j} + \ldots + \beta_{n+1} X_{nj}$$

where dij is the count of deaths and PYOij is the person years of observation for a particular age group i and combination of covariates j. Exposure times are incorporated in the model as an "offset" term.

Ages at death and exposure time are categorized into the following intervals: less than 28 days and 1-2, 3-11, 24-35 and 36-59 months. Regression models were used to explore mortality by selected socioeconomic status covariates such as household access to water, the number of household assets and remittances such as the child support grant. Indicators of health care access, demographic variables such as age and sex and the time trend in mortality across seven three-year time periods were also investigated.

Results
The presentation of the results will be in the form of graphs and tables. Figure 1 shows the average trends for boys and girls over the twenty year period in single years. Table 1 shows selected basic characteristics of women who were ever pregnant in the first round of data collection in 2000.

Figure 1: An average child mortality trend for boys and girls from 1981-2000 in single years:



Selected basic characteristics of women aged 15-49 who were administered a pregnancy questionnaire in the first data collection in 2000 are presented in Table 1.

Table 1: Selected basic characteristics of ever pregnant women (N = 40,842).

Characteristics of the women	N = 40,842
Age	**%**
15-19	4.2
20-24	10.5
25-29	14.3
30-34	17.2
35-39	20.0
40-44	21.2
45-49	12.6
Education	
None	15.8
Primary	34.2
Secondary	23.6
Metric &	12.8
Missing	13.5
Employment	
Full time	26.4
None	57.1
Part time	4.1
Missing	12.5
Sanitation	
Flush toilet	4.2
VIP/chemical	3.0
Open pit latrine	38.1
None	31.3
Missing	23.2
Watersource	
Piped(private/public)	33.3
Borehole,well,rainwater	21.2
River,dam	21.5
Missing	23.19
Household assets	
0-6	31.09
7-9	24.44
10+	21.22
Missing	23.26

Table 2 shows the association in the form of the relative risk of child mortality with residence and other socioeconomic variables and has been adjusted for age, sex and period.

Table 2: Association (RR) of child mortality with residence and socioeconomic variables adjusted for age, sex and period

Adjusted for age, sex and period		
	p-value	**RR**
Urban		1
Periurban	0.006	1.46
Rural	0.006	1.45
Missing	<0.001	1.96
Piped private or public		1
Borehole/well/rainwater	0.948	1.00
River or dam	<0.001	1.28
Don't know/ missing	<0.001	1.46
Flush toilet		1.00
VIP/Chemical	0.551	1.12
Open pit latrine	0.002	1.54
No toilet	<0.001	1.71
Missing	<0.001	2.14
Health facility		1
Home	0.001	1.24
Don't know/NA/missing info	<0.001	0.76
No ANC questionnaire	<0.001	0.45
Receiving the child grant		1
Non recipients	<0.001	1.36
Receiving the old age pension		1
Non recipients	0.308	1.06
None		1
Incomplete primary	0.035	0.88
Incomplete secondary	0.000	0.75
Matric & above	0.000	0.58
Missing SES data	0.106	1.12

Model building

The relative risks of the covariates and p-values of the basic model which includes age, sex and period and the same estimates of the final model are shown in Table 3. A full model including residence, water source, sanitation, birth setting, household assets, education, child support grant as well as age, sex and period was fitted. The pseudo-R^2 statistic which captures the overall variability of the variables that are included in the model increased minimally from 32.5% to 33.6%. A "post test" in STATA 9 was therefore performed to assess whether there were statistically significant differences for each of the variables. The results of these tests showed that residence, sanitation and assets all had p-values from the chi^2 test >0.05. These variables were therefore not included in the final model.

Table 3. Poisson regression estimates of risk ratio for childhood mortality

		Basic Model				Final Model			
Covariate	**Deaths**	**P-value**	**RR**	**lower**	**upper**	**P-value**	**RR**	**lower**	**upper**
Years before survey	**1998-2000**		**1.00**				**1.00**		
	1995-1997	<0.001	0.79	0.69	0.90	0.001	0.80	0.70	0.92
	1992-1994	<0.001	0.79	0.65	0.85	0.012	0.83	0.72	0.96
	1989-1991	<0.001	0.58	0.50	0.67	0.000	0.65	0.55	0.76
	1986-1988	<0.001	0.76	0.65	0.87	0.039	0.85	0.73	0.99
	1983-1985	<0.001	0.74	0.64	0.86	0.018	0.83	0.70	0.97
	1979-1982	<0.001	0.35	0.30	0.41	0.000	0.39	0.33	0.47
Sex	**Girl**		**1.00**				**1.00**		
	Boy		1.18	1.088	1.27	<0.001	1.18	1.10	1.28
Age group	**<28 days**		**1.00**				**1.00**		
	1-2 months	<0.001	0.020	0.015	0.03	<0.001	0.02	0.02	0.03
	3-5 months	<0.001	0.210	0.186	0.24	<0.001	0.21	0.19	0.24
	6-11 months	<0.001	0.011	0.008	0.02	<0.001	0.01	0.01	0.02
	12-23 months	<0.001	0.004	0.002	0.01	<0.001	0.01	0.00	0.01
	24-35 months	<0.001	0.105	0.090	0.12	<0.001	0.10	0.09	0.13
	36-47 months	<0.001	0.001	0.000	0.00	<0.001	0.00	0.00	0.00
	36-59 months	<0.001	0.057	0.046	0.07	<0.001	0.06	0.05	0.07
Water source	**Piped private/public**						**1.00**		
	Borehole/well/rainwater					0.506	0.96	0.85	1.09
	River/dam					0.002	1.21	1.07	1.36
	Missing socioeconomic data					<0.001	1.29	1.13	1.46
Place of delivery	**Health facility**						**1.00**		
	Home					0.029	1.16	1.02	1.32
	Don't know/NA/missing info					<0.001	0.73	0.66	0.80
Mother's education	**No Education**						**1.00**		
	Incomplete primary					0.042	0.88	0.78	0.99
	Incomplete secondary					<0.001	0.76	0.66	0.87
	Matric & above					<0.001	0.58	0.49	0.69
	Missing socioeconomic data					0.509	0.95	0.81	1.11
Child support grant	**Receiving the child grant**						**1.00**		
	Non recipients					<0.001	1.36	1.18	1.57

Disscussion

The 20 year trend of child mortality is identical to the national pattern seen in the 1998 South Africa Demographic and Health Survey, although the level is higher in this rural Kwa-Zulu Natal population. The under-five mortality trend shows gains had been made in child survival up until 1991, whereafter a gradual increase is seen. Infant mortality rose from 46 per 1000 live born children in 1990 to 89 in 2000 and under-five mortality from 64 to 116. These increases are consistent with the impact of an early stage of an HIV epidemic and are also consistent with model based estimates of child mortality in the ASSA2002 model for African children living in KZN.

From an analysis of national data (Nannan, Timaeus, 2007) the most important determinant of under-five mortality was population group with African neonates being more than 3 times more likely to die that White babies. This disadvantage more than doubled for the remaining years of early childhood whereby African children were 6.6 times more likely to die than White children with significantly higher mortality than Coloured and Asian children aswell. This differential was only partially accounted for by where the different population groups live and mother's education. While this study went some way to unravel the more "structural" determinants that impact on child health in South Africa, an analysis of the determinants in a more homogenous population where such factors would not play the same role would be informative around issues of for example watersource and sanitation and household assets. Other important factors known to be important in rural areas such as access to health facilities and recently the impact that government remittances have on very poor households by having an impact on the negative effects of poverty.

What determinants and the interaction between determinants are responsible for childhood deaths amongst a rural community living varying conditions of poverty and experiencing a most aggressive HIV epidemic. This set of circumstances has impacted on the household conditions, health services and other aspects of the environment which are known to contribute to the child survival.

In South Africa, since 1994 in particular important policies have been formulated that aim to address some of the issues that are critical to the improvement of child survival. Within a contextual framework that considers the proximate determinants of child survival from a public health perspective, the important government programs that have emerged are those related to providing health services, the improvement of basic housing conditions, the improvement in basic services, improvement in quality and coverage of education, increases in cash flows in the form of remittances that would have an impact on household income.

The model building process can be used to unravel the varying contributions of the determinants known to be important on child survival. The basic Model 1 exploring the age-sex-pattern of child mortality over time demonstrates that the covariates contained in this simple model result in an pseudo-R^2 statistic of 32.5%. The final model captures the additional effects of water source, delivery setting, education and being a recipient of the child support grant. The model building process shows that after controlling for age, sex and period all factors display significant associations with child mortality. The effect of adjusting for residence (urban, peri-urban and rural based on population density) makes sanitation less important and no longer statistically significant than water source. However, birth setting remains important and has a greater effect on child mortality as does maternal education and being a recipient of the child support grant.

This model results in a pseudo-R^2 statistic of 33.6% and therefore only accounts for one-third of the variability explaining the factors associated with childhood mortality. Clearly there are other contributing factors that are not captured by these covariates. Undoubtedly, one of these must be the effects of HIV and AIDS. Having said that the age pattern of mortality that is shown in these data is remarkably strong.

The government programs that would have some impact on child mortality would be factors related to heath services such as antenatal care, housing conditions such as the sources of household water and sanitation and the improvements that have influenced the education of women.

Of the health service indicators that may have had considerable contribution in answering this question such as the number of antenatal care visits, the delivery setting and type of care provider, these data suffer from recall bias in that the births that occurred furthest back in time have probably been recorded as missing, whereas the respondent has recall problems. However, some general trends can be shown with the data such as of the total number of antenatal care visits reported in the pregnancy histories. Only 4.4% of them occurred during 1970-1979, 22.7% occurred from 1980-1989 while 56.3% occurred in the 1990-1999.

It is difficult to assess the improvements in water and sanitation conditions in the same way but by looking at highest educational attainment by the mean age of women in each educational category, it is clear that the older women form the majority of the women with no education and in all the mean age decreases with higher educational attainment: None (6.4), primary (6.0), secondary (4.7) and matric+ (4.6) showing improvements over time. A relatively new policy thought to have far reaching consequences on child nutrition and therefore to impact on child health is the child support grant instituted in 1998. Although there would be more uptake from recipients after this round of data collection in 2000, this study shows that after adjusting for everything in the full model recipients of this grant have 35% lighter mortality than children who do not receive the grant.

Other government programs implemented since 1994 have aimed to redress the inequities in accessing health services. Improvements in health services related to the policy of free health care since 1994 allowing more people access have also impacted positively on child mortality and this study attests to this by showing that children born in a health facility have 15% reduced mortality risk compared to those born at home. There remains a strong mortality gradient by toilet type even after adjusting for residence as there also is for sanitation

The findings from these data reflect the changes that have occurred amongst a very poor rural community where socioeconomic conditions would be harsher than average conditions in the country. A study that uses national data (Burgard and Trieman, 2006) to assess improvements in living conditions that would impact on child mortality over a 10 year period that encompasses the change in government social policy with the democratic government however, concludes policies have not translated into better socioeconomic and living conditions that have had a positive impact on infant mortality.
Both of these enquiries have not incorporated HIV in any way and it's association with or impact on child mortality. This is a limiting factor and is surely, at least in part responsible for only accounting for one-third of the variability captured in the final model. It will also be important for future research to distinguish HIV mortality from non-HIV mortality.

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