Socioeconomic And Maternal Determinants Of Infant Mortality: An Analysis Using The Swaziland Demographic Health Survey 2007

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Abstract

This paper uses the 2007 Swaziland Demographic and Health Survey to investigate the impact of socioeconomic and maternal variables on infant survival. Results indicate that children born using Caesarean section had a higher risk of infant mortality. The infant mortality risk associated with multiple births was about 4 times higher relative to singleton births. Socioeconomic variables did not have a distinct impact on infant mortality. These results suggest that improving maternal and child health services, screening for high-risk pregnancies and making referral services for high-risk pregnancies more accessible, particularly to the rural women and children, will also contribute to improvement of infant survival rates.

INTRODUCTION

There is little research on the patterns of determinants of infant mortality in Swaziland. Existing studies are limited to analytical reports of censuses and surveys conducted by the Central Statistical Office. Swaziland is one of the smallest landlocked countries in the world, and according to the 2007 population census, the population of Swaziland reached 1.1 million, of which 99 percent lived in urban areas. In 2007 Swaziland conducted its first national survey as part of the Demographic and Health Surveys (DHS) (1). The 2006-07 Swaziland Demographic Health Survey (SDHS) is a nationally representative sample of 4,843 households, 4,987 women aged 15–49 years and 4,156 men aged 15–54 years. The survey of persons aged 12-14 and aged 50 and over was carried out in every other household selected in the SDHS yielding 459 girls and 411 boys aged 12-14, and 661 women and 456 men aged 50 and over. The survey aimed to gather information about child mortality, and maternal and child health, as well as family planning and other reproductive health issues.

Poor social conditions are known to affect maternal health, which again has impact on infant mortality (2, 3). Social developments such as improved maternal education, household income and environmental conditions should have effects on child mortality in developing countries (4, 5). Still, the impact of improved maternal education and other socioeconomic conditions on pregnancy outcome may depend on the cultural setting. Few studies have assessed how socioeconomic patterns are related to infant mortality in Africa (6-9). This paper presents an analysis of the impact of socioeconomic and maternal variables on infant mortality. The overall purpose of the paper is to determine the relative importance of various socioeconomic and maternal variables on infant mortality in Swaziland between 2002 and 2006.

METHODS AND MATERIALS

SOURCES OF DATA

The study used highly reliable data collected from the 2006/7 SDHS survey (1). The 2006/7 SDHS survey collected data from a sample of 4,987 women aged 15-49 years and 4,156 men aged 15-54 years. This SDHS is the first comprehensive survey conducted in Swaziland as part of the Demographic and Health Surveys (DHS) programme. The DHS are a rich source of data on developing countries in general, and Africa in particular. The empirical analysis in this paper for the independent variables is restricted to 5 years before the 2006/7 SDHS survey (2001-2006) so that the odds ratios are based on a sufficient number of cases in each category to ensure statistically reliable estimates.

STUDY VARIABLES

Infant mortality ($_1q$) is mortality from birth to the age of 12 months. The dependent variable is mortality status at one year. The independent variables that we studied in this paper were socioeconomic variables (maternal education, paternal

education, wealth index and area of residence), and maternal (and related) factors (child's birth order, preceding birth interval, maternal age, child's sex, type of birth).

Socioeconomic variables such as wealth status 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 breast milk alone. Previous studies have shown that short birth intervals (less than or equal to 18 months), high parity (6 or more children), low maternal age (less than 20 years) and high maternal age (35 and more years) adversely impact infant and child survival. 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 increase the autonomy necessary to advocate for her child in the household and the outside world. Infant mortality differentials by place of residence (rural-urban) are expected due to regional differences in health infrastructure, and communication and disease prevalence conditions. Place of delivery is also an important determinant of mortality, particularly neonatal mortality. Children delivered in modern health facilities usually exhibit lower rates of mortality. However, in some cases, mortality among children delivered in modern facilities is observed to be higher because mothers use these facilities mostly when they have pregnancy complications.

It is against this background that in this paper we study the selected demographic and socio-economic variables discussed above in order to determine their differential impact on infant mortality in Swaziland. Other variables from the classical proximate determinants model such as nutrient availability and incidence of injury are not examined because of the absence of sufficient information on the variables themselves from the 2006/7 SDHS survey data.

STATISTICAL ANALYSIS

Using contingency table analyses and logistic regression, the association between all possible factors and infant mortality was assessed. First, frequency tabulations were conducted to describe the data used in this study, followed by univariate logistic regression analyses to examine the impact of all potential predictors on neonatal mortality without adjusting for other covariates. All of the potential predictors were also entered into the baseline model to examine their effects simultaneously.

Logistic regression was then performed to identify the significant independent determinants of infant mortality. All variables that were significantly associated with infant mortality at the 10 percent level of significance from the univariate logistic regression models were included in the multivariate logistic regression model.

SDHS data sets have a hierarchical structure, with women or men within households, which are within EA's. This data structure violates an underlying assumption for usual logistic regression models of independence of the observations. Instead, the observations in these datasets are clustered within each EA. We adopted a design based modelling approach instead of the multilevel modelling methods frequently used in literature. Both of these approaches adjust for this clustering of observations within EA and provide correct estimates of the standard errors.

Odds ratios and 95 percent confidence intervals were determined, and all estimates were weighted by the sampling probabilities. Two variables, maternal age at child birth and household wealth index were chosen a priori and retained in the final model, regardless of their level of significance, because they have previously been shown to be associated with the increased risk of neonatal and infant mortality.

All of the statistical analyses were performed using R (10), and the logistic regression was conducted using the survey library (11, 12).

ETHICS

This study is based on an analysis of existing data with identifier information removed. It was reviewed and approved by the Swaziland Scientific and Ethics Committee at the

Ministry of Health and Social Welfare and Institutional Review Boards (IRB) at the Human Sciences Research Council and Macro International (13). The protocol was also reviewed at CDC Atlanta(13). All study participants gave informed consent before participation and all information was collected confidentially.

RESULTS

To identify the associated factors for infant mortality, 2,205 live-born infants within the five years preceding the survey were included as the study population. Only infants who could have lived to their first birthday are included in this analysis. This analysis found that between 2002 and 2007,

8.9 percent of infant deaths occurred during infancy.

Figure 1

Table 1: Percentage distribution of children by covariates used in the analysis of infant mortality

		Number of women	Births (%)	Deaths (Weighted IMR 95% CI)
Total		1820	2205	193(98.4: 84.1-115.2)
Type of place of residence (Valid=2205)				
	urban	489	565 (25.6)	55 (100.2: 69.2-131.1)
	rural	1331	1640 (74.4)	138 (86.7: 72.7-100.6)
District (Valid=2205)				
	hhohho	467	564 (25.6)	39 (74.1: 47-101.3)
	manzini	505	600 (27.2)	57 (97.1: 73.3-120.9)
	shiselweni	401	499 (22.6)	39 (82.5: 59.3-105.7)
	lubombo	447	542 (24.6)	58 (106.8: 78.9-134.8)
Marital status (Valid=2205)				
	never married	645	734 (33.3)	60 (86: 65.3-106.6)
	married/(not) living together	1114	1393 (63.2)	125 (90.5: 74-107.1)
	widowed/divorced	61	78 (3.5)	8 (107.5: 40.5-174.6)
Maternal education (Valid=2205)				
	primary or lower	804	1005 (45.6)	92 (90.2: 71.1-109.2)
	secondary or higher	1016	1200 (54.4)	101 (89.2: 72-106.4)
Paternal education (Valid=1444)				
	primary or lower	545	709 (49.1)	71 (100.4: 78.3-122.5)
	secondary or higher	609	735 (50.9)	59 (80.6: 58.9-102.3)
Mother's occupation (Valid=2202)				
	not working	962	1180 (53.6)	92 (78.5: 64.3-92.7)
	working	855	1022 (46.4)	101 (102.8: 80.5-125.2)
Paternal occupation (Valid=1444)				
	not working	166	211 (14.6)	17 (84.3: 45.4-123.1)
	working	988	1233 (85.4)	112 (90.7: 72.7-108.8)
Piped drinking water (Valid=2205)				
	no	931	1154 (52.3)	99 (86.5: 71.6-101.3)
	yes	889	1051 (47.7)	94 (93.1: 72-114.3)
Flush toilet (Valid=2203)				
	no	1517	1859 (84.4)	159 (87.4: 74.5-100.2)
	yes	302	344 (15.6)	34 (105.7: 64.6-146.8)
Wealth index (Valid=2205)				
	poor	711	898 (40.7)	72 (82.2: 63.2-101.1)
	middle	347	425 (19.3)	37 (84.9: 60.6-109.1)
	rich	762	882 (40)	84 (99.6: 77.1-122.1)
Age at first birth (Valid=2205)				
	< 18	668	806 (36.6)	81 (101.2: 78.2-124.2)
	18-24	1055	1279 (58)	104 (83.9: 66.6-101.2)
	25+	97	120 (5.4)	8 (73: 25.4-120.6)
Age at birth (Valid=2205)				
	< 20	441	511 (23.2)	44 (90.4: 64.2-116.5)
	20-34	1155	1429 (64.8)	132 (92.8: 76.2-109.3)
	35+	224	265 (12)	17 (70.5:35-106)
Sex of child (Valid=2205)				
	male	917	1103 (50)	97 (89.9: 71-108.9)
	female	903	1102 (50)	96 (89.3: 72.7-105.9)
Type of birth (Valid=2205)				
	single	1794	2147 (97.4)	179 (84.6: 72.4-96.8)
	twin	26	58 (2.6)	14 (271: 131.7-410.2)
Birth size (Valid=2137)				
	large	515	608 (28.5)	45 (71.4: 49.3-93.5)
	average	1016	1231 (57.6)	99 (86: 69.7-102.4)
	small	242	298 (13.9)	38 (122.4: 82.8-161.9)
Birth rank and birth interval (Valid=2205)				
	1st birth rank	621	680 (30.8)	60 (94: 68.7-119.2)
	2nd or 3rd rank, birth interval < 2years	97	150 (6.8)	13 (84.2: 36.7-131.7)
	2nd or 3rd rank, birth interval > 2years	551	661 (30)	60 (89.2: 66.1-112.3)
	4th rank and above, birth interval < 2years	77	128 (5.8)	18 (133.9: 74.5-193.2)
	4th rank and above, birth interval> 2years	474	586 (26.6)	42 (76.6: 52.3-100.8)
Delivery assistance (Valid=2198)				
	no assistance	1729	2096 (95.4)	186 (91.4: 78.2-104.6)
	some assistance	86	102 (4.6)	4 (35.6: 0.7-70.5)
Desire for pregnancy (Valid=2200)				
	then	686	823 (37.4)	85 (105.6: 80-131.1)
	later	455	571 (26)	48 (89: 63.9-114)
	no more	677	806 (36.6)	58 (72.4: 54.2-90.5)
Mode of delivery (Valid=2195)				
	Non-Caesarean	1662	2018 (91.9)	166 (83.4: 71.2-95.6)
	Caesarean	150	177 (8.1)	26 (161.3: 95.2-227.5)
Place of delivery (Valid=2199)				
	home	460	576 (26.2)	42 (70.8: 50-91.6)
	public facility	764	921 (41.9)	82 (93.5: 74.8-112.2)
	private facility	593	702 (31.9)	66 (97: 73.6-120.5)

The characteristics of the study variables are presented in Table 1. Only 37 percent of the infants were born to women who desired to be pregnant. Around 53 percent of the infants were born to mothers who did not have a job outside the home. Only less than 15 percent of infants were born to fathers who were unemployed. Approximately 26 percent of the deliveries occurred at home. This survey revealed that 95 percent of the deliveries were assisted.

Table 2 summarizes the crude and adjusted odds ratios of the possible factors associated with infant mortality. This study found a no variation in the odds of neonatal mortality by administrative district or by type of place of residence.

Figure 2

Table 2: Factors associated with infant mortality: unadjusted and adjusted odds ratio

Type of place of residence			0.364		
	urban	1			
	rural	0.852 (0.579 : 1.254)			
District			0.244		
	hhohho	1			
	manzini	1.344 (0.831 : 2.171)			
	shiselweni	1.123 (0.681 : 1.853)			
	lubombo	1.494 (0.913 : 2.445)			
Marital status			0.805		
	never married	1			
	married/(not) living together	1.058 (0.764 : 1.466)			
	widowed/divorced	1.281 (0.596 : 2.756)			
Maternal education			0.937		
	primary or lower	1			
	secondary or higher	0.988 (0.723 : 1.351)			
Paternal education			0.189		
	primary or lower	1			
	secondary or higher	0.785 (0.544 : 1.134)			
Mother's occupation			0.047		0.051
	not working	1		1	
	working	1.346 (0.986 : 1.836)		1.375 (0.984 : 1.920)	
Paternal			0.756		
	not working	1			
	working	1.085 (0.622 : 1.891)			
Piped drinking water			0.583		
	no	1			
	yes	1.085 (0.796 : 1.480)			
Flush toilet			0.325		
	no	1			
	yes	1.235 (0.789 : 1.935)			
Wealth index			0.409		0.691
	poor	1		1	
	middle	1.036 (0.694 : 1.545)		1.020 (0.666 : 1.563)	
	rich	1.236 (0.863 : 1.770)		1.165 (0.802 : 1.693)	
Age at first			0.332		0.011
	< 18	1		1	
	18-24	0.814 (0.574 : 1.153)		0.638 (0.444 : 0.916)	
	25+	0.699 (0.331 : 1.480)		0.377 (0.158 : 0.899)	
Age at birth			0.492		0.431
	< 20	1		1	
	20-34	1.029 (0.706 : 1.501)		0.999 (0.665 : 1.501)	
	35+	0.764 (0.407 : 1.432)		0.691 (0.339 : 1.411)	
Sex of child			0.957		
	male	1			
	female	0.992 (0.732 : 1.344)			
Type of			0.000		0.000
	single	1		1	
	twin	4.020 (1.983 : 8.149)		4.054 (2.001 : 8.214)	
Birth size			0.045		0.040
	large	1		1	
	average	1.224 (0.828 : 1.811)		1.196 (0.810 : 1.767)	
	small	1.814 (1.097 : 2.998)		1.862 (1.149 : 3.017)	
Birth rank and birth interval			0.381		
	1st birth rank	1			
	2nd or 3rd rank, birth interval < 2years	0.886 (0.439 : 1.788)			
	2nd or 3rd rank, birth interval > 2years	0.944 (0.622 : 1.433)			
	4th rank and above, birth interval < 2years	1.490 (0.854 : 2.599)			
	4th rank and above, birth interval > 2years	0.799 (0.495 : 1.289)			
Delivery			0.030		0.113
	no assistance	1		1	
	some assistance	0.367 (0.138 : 1.025)		0.398 (0.116 : 1.364)	
Desire for pregnancy			0.061		0.013
	then	1		1	
	later	0.827 (0.563 : 1.215)		0.710 (0.484 : 1.040)	
	no more	0.661 (0.435 : 1.004)		0.578 (0.376 : 0.889)	
Mode of delivery			0.001		0.014
	Non-Caesarean	1		1	
	Caesarean	2.114 (1.283 : 3.483)		1.865 (1.163 : 2.990)	
Place of delivery			0.196		0.966
	home	1		1	
	public facility	1.354 (0.919 : 1.995)		1.060 (0.707 : 1.588)	
	private facility	1.410 (0.948 : 2.098)		1.054 (0.678 : 1.637)	

In the unadjusted model, the odds of dying are more than 35 percent higher for infants born to working mothers when compared to infants born to non-working mothers. Twins are also four times more likely die by their first birthday when compared to singletons. Infants born to women who did not have assistance during delivery are 3 times more likely to die when compared to women who had some assistance. For newborns, whose birth size according to the mother was smaller than average, the odds of dying were twice the odds for large-sized babies. Another important predictor for infant mortality was the mode of delivery. Compared to infants born vaginally, the odds of dying was significantly higher for infants born using Caesarean section (OR = 2.11, 95% CI: 1.28-3.48). The odds of dying for children using Caesarean section are marginally reduced in the multivariate model (OR = 1.86, 95% CI: 1.16-2.99). Desire for pregnancy also plays a significant role in determining the probability of infant death at by one year. Strangely, infants

born to women who desired the pregnancy are more likely to die when compared to infants born to women who wanted no more children or those who wanted the pregnancy later.

In the multivariate analysis, age at first birth plays a significant influence on infant mortality. Infants born to women who had their first birth from 25 years of age had more chances of survival compared to infants born to women who had their first child by 18 years.

DISCUSSION

The results of the multivariate analysis presented in this paper show that the influence of mother's education on infant mortality is insignificant in Swaziland. Birth rank and birth order also had an insignificant influence of infant mortality. Although insignificant in the multivariate model, infants born to working mothers have a higher risk of dying by age one. On sanitation, the findings indicated that the provision of piped drinking water and flush toilets to households have no impact on infant mortality. The findings presented in this paper provide further evidence that in Swaziland multiple births and Caesarean delivery are strongly negatively associated with infant survival. This suggests that improving maternal and child health services, screening for high-risk pregnancies and making referral services for high-risk pregnancies more accessible, particularly to the rural women and children, will contribute to improvement of child survival rates.

This analysis also supports the assertion that low birth weight has a negative impact on infant survival (14, 15). Mothers in deprived socioeconomic conditions have low birth weight infants (14, 15). In these settings, the infants' low birth weight stems primarily from the mothers' poor nutrition and health over a long period of time, including pregnancy, the high prevalence of specific and non-specific infections, or from pregnancy complications underpinned by poverty (14, 15).

METHODOLOGICAL LIMITATIONS

This study had several strengths. First, the 2006–07 SDHS was a nationally representative survey, using standardized methods that achieved high individual and household response rates. The second was the use of infant survival data from a five-year period preceding the survey, which has been shown to reduce recall errors about birth and death dates by the interviewed mothers. The third was the use of the design based modelling that took into account all features of the data as well as the variability within the community, household and individual levels to better estimate the level of association of the study factors with the outcome.

However, the study had several limitations that should be noted when interpreting the results. First, only surviving women were interviewed, which may have lead to an underestimate of the neonatal mortality rate, because of the association of neonatal deaths with maternal deaths. This could also have lead to an underestimate of the effect of some of the associated factors, such as delivery complications. Second, there are other possible determinants of neonatal mortality, which were not available in the SDHS dataset, such as environmental and genetic factors, or were only available for the most recent delivery of a mother occurring within the last five years preceding the survey, such as the utilization of antenatal care services. Third, several variables in the study were not infant-specific because they only reflected the most recent conditions or birth, such as maternal and paternal occupation, which represented the employment status within the last twelve months preceding the survey.

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