The determinants of the child mortality rate in rural Namibia

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Abstract
From a policy perspective, the most useful information about child mortality is its determinants. Hence, during the 20th and 21st centuries, researchers have increasingly turned their attention to identifying factors associated with low child mortality in developing countries. The identification of factors that account for variations in childhood mortality is essential in the formulation of policies and programs that aim to reduce child mortality. This paper analyses and compares the determinants of child mortality in Namibia, nationally, and in the two rural regional health directorates (RHDs), namely the Northeast and Northwest, using the 2006-07 Namibia Demographic and Health Survey. The Cox proportional hazard model is applied to assess the relative effects of the independent variables on child mortality. The results show that short birth intervals and widowed or divorced mothers had the highest risk of child mortality ($p < 0.001$) in Namibia as a whole as well as in the two rural RHDs. Whilst the variables of a toilet facility and mothers' education showed significance in both the Northeast and Northwest RHDs, their risks were lower in the Northwest. The variation by the sex of the household head only had a distinct impact in the Northeast RHD. These findings support policy initiatives that encourage longer birth intervals via the strengthening of contraceptive use through broader programs of sexual and reproductive health. The results of this study are also expected to guide policy makers and programme managers in the health sector to formulate targeted intervention programs to reduce child mortality in the rural regions of Namibia.

Introduction

The focus on non-income dimensions of development were initially introduced and promoted through the Basic Needs Approach and the composite Physical Quality of Life Index in the 1970s (Morris, 1978). Since then, there has been a global consensus that other variables such as infant and maternal mortality levels, literacy, educational attainment and material living standards such as housing, environmental factors, nutritional status, etc., should be used to indicate countries' development statuses.

In 1990, the United Nations Development Programme (UNDP) has strongly advocated a similar position in its Human Development Index (HDI). Since then, a number of socio-demographic studies have indicated that low indicators of health and education in poor countries are not only the consequences of underdevelopment but also the cause (Caldwell, 1989; Rutstein, 2000; Imam & Koch, 2004). For instance, Wood and Lovell (1992, p. 704) state that "infant and child mortality rates bear a direct and obvious relationship

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 Journal for Studies in Humanities and Social Sciences
Volume 2, Number 1, June 2013 - ISSN 2026-7215

to human welfare". Similarly, the International Development Targets (IDTs) and the successor Millennium Development Goals (MDGs) have also explicitly adopted a range of social goals as poverty reduction goals. MDG 4 is set to reduce under-five mortality rate by two thirds between 1990 and 2015 in developing countries. Consequently, researchers have increasingly turned their attention to identifying factors associated with low child mortality in developing countries. They argue that identifying factors that account for variations in childhood mortality is essential in the formulation of policies and program interventions that aim to reduce infant and child mortality. It is generally assumed that the implementation of numerous interventions designed to improve some of the essential factors has resulted in global child mortality decline from 93 per 1 000 live births in 1990 to about 72 per 1 000 births in 2006; ranging from less than 10 per 1000 live births in industrialised countries and the highest of 187 per 1 000 per live births in Sub-Saharan Africa (UNICEF, 2007, p.18). Although child mortality in Sub-Saharan Africa has declined from a level of 184 deaths per 1 000 live births in 1990 to 157 deaths per 1 000 live births in 2006, the World Health Organisation (WHO, 2009) argues that this progress is far too slow for meeting MDG 4 by 2015.

The situation of child health in Namibia has remarkably improved since the early 1980s. Infant mortality declined from 71 deaths per 1 000 live births in 1980 to 45 deaths per 1 000 live births in 2006. Similarly, under-five mortality rates declined from 108 deaths per 1 000 live births in the 1980s to 69 deaths per 1 000 live births in 2006 (WHO, 2009, p. 31). Unfortunately, the consistent reduction experienced between 1980 and 2000 has slowed down since 2000. Estimates from the Demographic and Health Survey (DHS) suggest an increase in both infant and under-five mortality rates for some periods between the 2000 DHS and the 2006/07 DHS [Ministry of Health and Social Services (MoHSS, 2008)]. The increment in child mortality rates has been attributed to HIV/AIDS and inadequate nutrition among mothers and children [National Planning Commission (NPC, 2008)]. Extrapolating the 2000-2006 rate of reduction in under-five mortality towards the 2015 MDG 4 target, the WHO (2009, p. 31) concluded that the expected number will be 45 deaths per 1000 live births, which is 1.5 times higher than the set target of 29. However, it should be noted that the above extrapolation refers to a national aggregate. Yet, it is a well known fact that national indicators generally mask disparities by location and socio-economic groups within the country. Thus, the rate of progress towards achieving the two-thirds reduction in child mortality rates could even be much slower among some socio-economic population groups. For example, the highest under-five mortality rate (95 deaths per 1 000 live births) was observed in Ohangwena region in the Northwest regional health directorate (RHD). This was followed by Caprivi region in the Northeast RHD with an under-five mortality of 93 per 1 000 live births, whilst the lowest rate of 49 deaths per 1 000 was observed in Kunene region in the Central RHD. As expected, under-five mortality was 1.3 times higher in rural areas than urban areas (MoHSS, 2008, p. 102; WHO, 2009, p. 31-32). The factors associated with variations in childhood mortality as observed in Namibia are not unique. They are consistent with those observed in demographic studies from other developing countries. Examples of such studies include the Sub-Saharan Africa study by Imam and Koch (2004), a study on Malawi by Mwale (2004), and a study conducted in Bangladesh by Mondal et al. (2009). Nevertheless, a number of reviewed studies on the determinants of childhood mortality were focused on one population level (such as national, urban or rural), while comparative studies were often focused on the urban-rural variations of childhood mortality. These types of studies seem to assume that urban or rural populations are homogeneous. Thus there is still paucity in studies that compare variations in the determinants of childhood mortality either within urban populations or rural populations.

This paper identifies and compares factors that are strongly associated with child mortality between two rural populations in Namibia, namely the Northeast and Northwest regional health directorates (RHDs)[1]. Studies of this nature are important as they unmask the differentials in factors associated with child mortality within rural populations located in different social and geographical settings. The results obtained from this type of study are essential as they enable policy makers to formulate policies and program interventions that are more focused and targeted towards specific rural populations to accelerate the achievement of MDG 4 by 2015 and beyond.

The conceptual framework

The conceptual framework underlying the analyses in this paper is based on the Mosley-Chen model (1989) on the determinants of child mortality (Figure 2.1). The development of this framework was prompted by observed disparities between social science research, which focused largely on roles of socioeconomic and cultural factors in child deaths, and medical research, which focused on specific disease processes and used morbidity as the common outcome variable. Thus, the framework aimed to integrate the two research methodologies and to introduce a single variable that combined both mortality and morbidity (Hill, 2003, p. 138).

The Mosley-Chen model categorises the determinants of childhood mortality into two groups: distal and proximate determinants.

Distal (indirect) determinants

Distal determinants include, among others, parental education, power relationships within the household, the value of children, beliefs about disease causation, food preferences, household income/wealth, availability of clean water and sanitation, household conditions and location, i.e. urban/rural, ecological setting, climate, temperature, rainfall and access to health care.

Proximate (direct) determinants

These include, among others, maternal factors (age at birth, parity and birth intervals), environmental contamination (intensity of household crowding, household food contamination or potential faecal contamination), nutrition deficiency (nutrition availability to the infant or the mother during pregnancy and lactation), injury (recent injuries, pregnancy- or delivery-related injury or disabilities) and personal illness control (use of prevalence services such as immunisation and prophylactics - e.g. against malaria or for antenatal care - and use of curative measures for specific conditions) (Mosley, 1989).

1 The health sector reform after independence structured health service delivery on two levels. The first level is the four Regional Health Directorates (RHDs) with the responsibility for a number of governments administrative regions (GARs) ranging from two (2) to four (4) GARs per RHD. The 13 GARs were centralised into the four (4) RHDs as follows: 1) Northwest RHD consisting of four GARs: Ohangwena, Omusati, Oshana and Oshikoto; 2) Northeast RHD comprised of two GARs: Caprivi and Kavango; 3) Central RHD consisting of three GARs: Erongo, Kunene and Otjozondjupa; and 4) South RHD which consists of four GARs: Khomas, Omaheke, Hardap and Karas (MoHSS, 1998). Thus, on the second level (operational level) are 13 GARs with 'regional health teams' which are decentralised into Districts. However, at the time when this paper was written, the four RHDs were already phased out under the decentralised policy in 1997-98 (Dovlon, 2001 and Bell et al., 2002). However, due to the smallness of the DHS samples, it is not possible to disaggregate the mortality analysis by 13 GARs. Therefore, mortality analyses in this paper were based on the former RHDs.

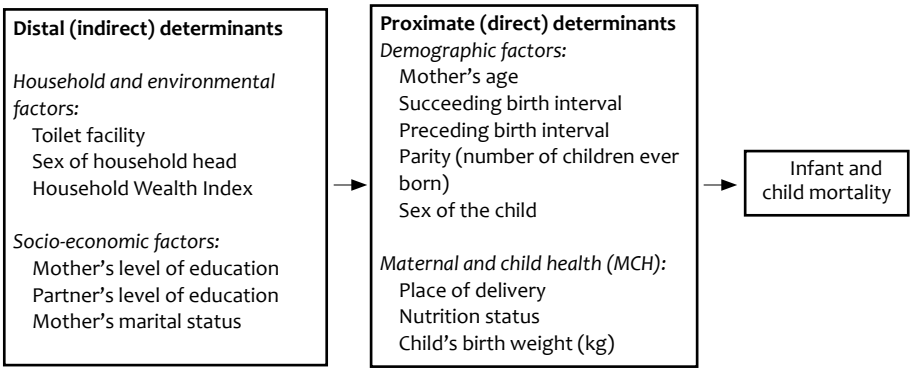

Figure 1 **The conceptual framework for the deterninants of child mortality**

The Mosley-Chen conceptual framework model illustrated above (Figure 2.1) is based on the idea that socio-economic factors manifest themselves in measurable proximate determinants. The cumulative values of these variables (socio-economic factors and proximate determinants) then influence the body's ability either to remain healthy and resist diseases, or to increase the risk of injuries and disabilities or its susceptibility to diseases, which link to the probability of child death (Hanmer, Lensink & White, 2003). In the explanation of their conceptual framework, Mosley and Chen argue that both child mortality and child growth are affected by the same set of underlying nutritional and infectious conditions, such that weight-for-age can be regarded as a measure of health status rather than solely of nutritional status.

The purpose and objectives of the study

This paper investigates the determinants of child mortality in Namibia and the four rural Regional Health Directorates (RHDs) using the 2006-07 Namibia Demographic and Health Survey (NDHS).

The objectives of the study are:

- To identify the factors that are significantly associated with childhood mortality in Namibia and in the two rural regional health directorates, namely the Northeast RHD and the Northwest RHD.
- To compare the differences in the factors that are significantly associated with childhood mortality between the Northeast and the Northwest RHDs.
- To make targeted policy recommendations for the achievement of MDG 4 among rural populations.

Data and methods

Source of data

The 2006-07 NDHS is part of a series of surveys that are regularly conducted by the Ministry of Health and Social Services (MoHSS) in collaboration with the Central Bureau of Statistics (CBS) and Macro International. The 2006-07 data were collected between October 2006 and January 2007 and included 9 802 interviews with a representative probability sample of women aged 15-49 (for details on sampling, see MoHSS, 2008, p. 281). The DHS questionnaires covered a variety of demographic topics, among others the background characteristics of the women as well as complete birth histories of children born 5 years before the survey (2001-2006). The birth histories provided information on the survival status of the child, birth intervals, ante- and postnatal care, place of delivery, birth weights, breastfeeding and immunisation. The birth histories reported a total number of 6 163 children who were born within the 5 years before the 2001-2006 survey in Namibia.

Data limitations

The limitation in the current paper relates to the general usage of birth histories in mortality studies. The information collected from birth histories is generally attached to the characteristics of the mother that may not have the same time reference as the mortality data (Mbacké & Van de Walle, 1992; Sibanda & Zuberi, 2005). For example, women in the 2006-07 NDHS were enumerated at the household where they were listed during the enumeration period (de facto survey). Thus, some of the women interviewed in the survey may not have been staying in the same locality throughout the 5 year period before the survey. Some of the women were also not counted at their usual place of residence, and thus the household and environmental factors listed in the survey may not necessarily relate to their births in the last five years before the survey. These phenomena may bias the association between the predictor variables. Likewise, the interactions of some of the achieved predictor variables on the dependent variable might also be affected because of the timing. For example, the marital status and the education status reported in 2006-07 referred to current status, and may not necessarily have been the actual status of the mother at the time of birth or death of the child (Sibanda & Zuberi, 2005).

Study sites

The Ministry of Health and Social Services (MoHSS), with its head office in Windhoek (Namibia's capital city), is currently the main provider of public health services in Namibia. At independence, the health services were decentralised into the thirteen (13) government administrative regions (GARs) through regional health management. The GARs were sub-divided further into four regional health directorates (RHDs), namely, Northwest, Northeast, Central and South. However, by the time this paper was written, the four RHDs were already phased out under the decentralised policy in 1997-98 (Dovlo, 2001 & Bell et al., 2002). The previous directorates that were overseeing RHDs were phased out and their responsibilities shifted to the new regional health management teams, who now manage the health and social services within each of the 13 GARs in close collaboration with their respective regional councils (Dovlon, 2001; el Obeid et al, 2001). Due to the smallness of the DHS samples, it was not possible to disaggregate the current analysis by 13 GARs. Therefore, the analyses in this study were focused on the (phased out) four RHDs. Whereas the majority of the population in South and Central RHDs are mainly urban, and derive their livelihoods from subsistence farming, a large proportion of the populations residing in the Northwest RHD are Oshiwambo speaking and share almost the same culture. In contrast, populations in the Northeast RHD speak Rukavango and Caprivi languages and

have considerably different cultural practices. Combined, the Northeast and Northwest RHDs host the majority (58 percent) of Namibia's population (CBS, 2006, p. 9). The two Northern RHDs were the main source of contract migrant labour during the apartheid era, with destinations to the South and Central RHDs. Yet, due to limited paid employment opportunities in these regions, the economic feature of migrant labour is still continuing after independence. Even though migrant labour has been altered in many ways, its basic element - the absence of labourers from their families and low wages - is still negatively impacting on the agricultural activities, food security and social structures in the two RHDs (Hishongwa, 1992; El Obeid et al., 2001). Moreover, the 2008 review of poverty in Namibia shows that the two RHDs also shoulder the highest levels of poverty. The Kavango region in the Northeast RHD and the Ohangwena region in the Northwest RHD have the highest levels of poverty and the largest share of poor households (CBS, 2008).

There is a relative relationship between the climate, environmental factors and prevalence and burden of diseases in the four RHDs. For example, malaria is the most common cause of morbidity and mortality for both adults and children in the Northwest and Northeast RHDs. Diarrhoea, cholera and pneumonia are also prevalent among under-fives. Malaria outbreaks mostly occur during the rainy season - between the months of January and June - in the Northeast RHD. By contrast, incidences of diarrhoea in the Northwest occur during the dry season, just before the rainy season when the water quality in the village is worst (MoHSS, 2008; El Obeid, 2001). HIV/AIDS has also exacerbated the disease burden in the two RHDs. According to the 2010 National HIV Sentinel Survey among pregnant women, Katima Mulilo district, located in the Northeast RHD recorded the highest rate (36.6%) of HIV prevalence (MoHSS, 2010, p. 16).

Method of analysis

The significance of the associations between the outcome (child dead) and the predictor variables was tested by simple cross tabulation, chi-square test and Cox proportional hazards regression. Analyses were performed separately for Namibia (national) and for the two rural RHDs (Northeast and Northwest) and associations were set to be significant at a p-value of .05 or lower.

The Cox proportional regression model is a widely applied method of survival analyses, designed for analysis of time until the event or time between events. Since it is a semi-parametric model, the Cox proportional regression model does not require the researcher to specify the form of distribution of baseline hazard rate. The model assumes that if the predictor variables affect the hazard, it does so by the same ratio at all times, thus the hazard rate increases lineally with time. The Cox proportional model allows the use of time-varying covariates, i.e. covariates may be either time fixed or time-dependent (SPSS Advanced Model 15, 2006; Bruce, et al, 2008). Cox's model enables us to assess whether these time varying covariates increase or decrease the timing of the risk (called the hazard ratio) of dying before the age of five. However, it assumes that the hazard ratio depends only on the predictors, and not on time, as it is constant over time. The interpretation of the hazards ratio is similar to that of odd ratios in a logistic model. When the hazard ratio is greater than 1, it means that there is a high risk of occurrence of death in the corresponding covariates in comparison to the reference covariates. Conversely, the risk of death is lower when the hazard ratio is less than 1 and a hazard ratio that is equal to 1 indicates that the hazard is equal to the baseline hazard (BEGUY, 2009). The Cox proportional hazard model can mathematically be expressed as:

Relative Hazard:

$$\left(\frac{h(t)}{h_0(t)}\right) = \exp(\beta_1\chi_1 + \beta_2\chi_2 + \ldots \beta_k\chi_k)$$

Or

Log-Relative Hazard:

$$\log\left(\frac{h(t)}{h_0(t)}\right) = (\beta_1\chi_1 + \beta_2\chi_2 + \ldots \beta_k\chi_k)$$

Where h(t) is the hazard function at time t.; $h_o(t)$ is the baseline hazard or the hazard for an individual when the value of all the predictor variables equals zero.

$\beta_1, \beta_2, \ldots \beta_k$ are the coefficients for predictor variables $\chi_1, \chi_2, \ldots \chi_k$.

Based on the reviewed literature, a number of proximate and indirect determinants (Mosley & Chen, 1984) were identified as potential predictors of the risk of dying before the age of 5. The best model of predictors was determined by looking at the significance level of the Chi-Square tests. The 5% significance level was used as a basis for deciding if a particular variable should be retained in the model. The retained variables (significant in Namibia, Northeast or in the Northwest) were subjected to Cox's proportional hazard model.

Results

Table 7.1 shows the frequency of children born in the last five years before the survey (2001-2006) at the national level and in the two rural RHDs (Northeast and Northwest). During the 5-year period before the 2000 DHS, a total of 6 163 births were reported among sampled women aged 15-49 in Namibia. At the time of the survey, 369 (6%) of these births were reported dead. A total 1 161 births were recorded in the Northeast RHD and 77 (7%) were reported dead at the time of the survey. The Northwest RHD reported a total of 2 241 births for the 5-year period before the survey and 157 (7%) of these births were reported dead at the time of the survey.

Outcome variable child alive/dead	Frequency	Proportion Alive/dead	Percentage
Namibia			
Yes	5794	0.94	94%
No	369	0.06	6%
Total	6163	1.00	100%
Northeast			
Yes	1084	0.93	93%
No	77	0.07	7%
Total	1161	1.00	100%
Northwest			
Yes	2084	0.93	93%
No	157	0.07	7%
Total	2241	1.00	100%

Table 7.1: **Children alive/dead among births in the last five years before the survey (2001-2006): Namibia, Northeast and Northwest RHDs**

Tables 7.2 & 7.3 show a comparison of proportion of 'children dead', tabulated by the predictor variables. An examination of Tables 7.2 & 7.3, shows that the Northwest RHD has a relatively higher proportions of 'children dead' compared to the National level and the Northeast RHD across eight variables. However, based on the chi-square statistical test results, seven (7) out of the 13 variables (birth interval, parity, place of delivery, birth weight, toilet facility, mother's education and marital status) are significantly associated with the risk of dying before the age of five. In contrast, the Northeast RHD recorded lower proportions of 'children dead' across the 13 variable categories, and five (5) of the variables (birth interval, birth weight, toilet facility, sex of household head, and mother's education) are significantly associated with the risk of dying before the age of five. Apart from mother's age, place of delivery, sex of household head, birth weight and partner's education which has no significant statistical association, all other predictor variables are significantly associated with the risk of dying before the age of five at the national level.

Table 7.2: **Proportion of 'children dead' by predictor variables and chi-squares: Namibia, Northeast and Northwest RHDs (NDHS, 2000)**

Proximate Determinants	Categories	Namibia	Northeast	Northwest
1. Demographic factors				
1.1 Mother's age at the time of interview	< 20	0.054	0.055	0.090
	20-34	0.057	0.069	0.061
	≥ 35	0.069	0.063	0.091
	χ^2	(NS)	(NS)	(6.64)*
1.2 Succeeding birth interval [time duration in months between the current birth (dead) and next birth]	< 24	0.174	0.270	0.234
	≥ 24	0.053	0.041	0.075
	χ^2	(60.77)***	(25.14)***	(28.042)***
1.3 Preceding birth interval [time duration in months between the current birth (dead) and the previous birth]	< 24	0.081	0.090	0.114
	≥ 24	0.059	0.060	0.070
	χ^2	(4.17)*	(NS)	(5.084)*
1.4 Parity (Number of children ever-born)	1	0.041	0.074	0.035
	2-3	0.058	0.055	0.069
	≥ 4	0.075	0.076	0.094
	χ^2	(17.33)***	(NS)	(15.90)***
1.5 Child's sex	Male	0.067	0.063	0.079
	Female	0.053	0.069	0.061
	χ^2	(5.61)*	(NS)	(NS)
2 Maternal and Child Health (MCH)				
2.1 Place of delivery	Homes	0.069	0.063	0.092
	Public and Private health sectors	0.056	0.067	0.060
	χ^2	(NS)	(NS)	(4.67)*
3 Nutritional Status				
3.2 Child's birth weight (in kilograms)	< 2500	0.075	0.101	0.102
	≥ 2500	0.058	0.063	0.062
	χ^2	(NS)	(2.00)*	(4.15)*

χ^2 (One-tailed test) ***p<.001, **p<.01; *p ≤.05; NS = not significant

Table 7.3: **Proportion of 'children dead' by predictor variables and chi-squares: Namibia, Northeast and Northwest RHDs (NDHS, 2006)**

Distal (Indirect) Determinants	Categories	Namibia	Northeast	Northwest
4. Household and environmental factors				
4.1 Type of toilet facility: defined as (a) unsafe facility = bucket, no facility, bush, pit toilet, traditional pit latrine	Unsafe facility	0.058	0.109	0.078
(b) safe facility = flush toilet, pour flush toilet, ventilated improved pit latrine	Safe facility	0.036	0.061	0.047
	χ^2	(8.74)**	(4.72)**	(5.87)**
4.2 Sex of household head	Male	0.059	0.075	0.065
	Female	0.061	0.052	0.073
	χ^2	(NS)	(2.23)*	(NS)
4.3 Household Wealth Index	Poor/ poorest	0.068	0.061	0.077
	Middle	0.064	0.062	0.072
	Rich/ Richest	0.048	0.098	0.048
	χ^2	(8.82)**	(NS)	(NS)
5. Socio-economic factors				
5.1 Mother's highest level of education	No education	0.073	0.047	0.091
	Primary	0.056	0.061	0.067
	Secondary & Higher	0.046	0.047	0.057
	χ^2	(9.84)**	(2.55)*	(8.70)**
5.2 Partner's highest level of education	No education	0.054	0.074	0.089
	Primary	0.064	0.058	0.076
	Secondary & Higher	0.062	0.053	0.057
	χ^2	(NS)	(NS)	(NS)
5.3 Mother's marital status	Never married	0.056	0.066	0.067
	Married	0.057	0.070	0.057
	Living together	0.060	0.060	0.080
	Widowed/ Divorced	0.091	0.080	0.144
	χ^2	(8.30)*	(NS)	(11.70)**

χ^2 (One-tailed test) ***p<.001, **p<.01; *p ≤.05; NS = not significant

The Cox proportional hazard model results (Tables 7.4 & 7.5 below) show the association between the predictor variables (stratified in categories) and the hazard ratio (HR) of dying before the age of five. The results are presented in the form of odd ratios (e^B) that indicate the direction (i.e., decrease, increase or no change) of change in the outcome variable associated with a one-unit change of a predictor variable. A HR of 1.00 implies no difference in the odds of a child dying before the age of five between the categories, while a HR greater than 1.00 indicates an increase in the risk of a child dying. Lastly, a HR below one indicates a decrease in the risk of a child dying relative to the reference category.

The results from the Cox model on the risk of dying before the of age five show that shorter succeeding birth intervals of less than 24 months increase the risk of dying before the age of five (HR = 2.1 for Namibia; 3.5 for Northeast RHD and 3.5 for Northwest RHD). All hazard ratios are statistically significant at $p < 0.001$. Shortened (succeeding) birth intervals are interrelated with shorter duration of breastfeeding. Shorter birth intervals generally also suggest a replacement effect, where a mother whose previous child has died attempts to replace her/him immediately (Udjo, 1997). However, this may not always be a deliberate action. The results from the reviewed studies have also found a significant negative association between the duration of breastfeeding and the risk of dying before the age of five. Owing to these results, it is important to note that the death of an infant in itself abruptly stops breastfeeding and simultaneously shortens the postpartum amenorrhea, and unless the woman uses contraceptives, this will also shorten the period of non-exposure to the risk of pregnancy and hence shorter birth intervals (Udjo, 1997).

High parities (4 children or more) were significantly associated with child mortality risk in Namibia but were insignificant in the Northeast and Northwest RHDs. Despite the fact that rural areas are generally associated with poor access to health services, the current study did not find any statically significant association between the place of delivery and the risk of dying before the age of five in Namibia or in any of the two RHDs. Analysing the 2006/07 DHS, WHO (2009) reported that about 81% of all births in Namibia took place in a health facility. However, the percentage of usage of health facilities was higher (98%) for women from high income homes as compared to 58% for women from low income homes. Lower usage (49%) of health facilities is also associated with women who have no education. The findings from the WHO (2009) study may signify an interaction between income, education and the usage of a health facility for delivery.

In measuring the effect of nutrition status of mothers on their children (especially during pregnancy), the results show that children with a low birth weight (< 2500 grams) are more at risk of dying before the age of five than those with a birth weight of ≥ 2500 grams (HR = 1.5 for the Northeast RHD and HR = 2.5 in the Northwest RHD). However, the variable of birth weight has shown no statistical significance at the national level.

The variable of type of toilet facility was significant ($p = 0.05$) at the national level as well as in the rural RHDs (Northeast and Northwest). For example, the results indicate that children born to mothers in a household with an unsafe toilet facility in the Northeast have a triple risk (HR = 2.6) of dying relative to those in a household with a safe toilet facility. However, the HR was somehow lower in the Northwest RHD (HR = 1.3). Contrary to the popular belief that male-headed households have a stronger resource base and may be associated with lower child mortality, children from male-headed households in the Northeast were slightly more at risk of dying before the age of five (HR = 1.3, $p = 0.05$) than those from female-headed households. On the contrary, the sex of the household

head has shown no statistical significance at the national level or in the Northwest RHD. Surprisingly, the variable of household wealth index has shown no statistical significance in the Northeast and Northwest RHDs, even though the two RHDs host the regions with the highest levels of poverty, namely Kavango and Ohangwena (CBS, 2008, p. 10).

The results show a difference in the risk of dying before the age of five between children born to women with no education (HR = 1.3) and those with secondary school (HR = 1.6) in Namibia. Conversely, children born to women with no education are more likely to die (HR = 2.3) before the age of five than those in the reference category in the Northwest, whilst those born to women with secondary education are more likely to die (HR = 1.6) than those in the reference category (secondary education and higher). These findings support evidence from other research studies that suggest that maternal education serves as a catalyst for optimum use of health facilities for MCH. Education also operates as a proxy to other socio-economic factors such as income, employment status, place of residence and other environmental household factors (Caldwell, 1989). The effect of maternal education on child survival shows no statistical significance in the Northeast RHD.

Marriage in Namibia occurs remarkably late and seems insignificant as a proxy of childbearing, relative to other countries. According to the 2006/7 NDHS, a large proportion of women (58%) aged 15-49 were reported as never married. The median age at first marriage among women aged 30-49 was 28 years, yet more than 15% of the women under the age of 20 years were already mothers, while 3% were pregnant with their first child (MoHSS, 2008, pp. xxi, 26). Nevertheless, the current study found that marriage was a significant ($p < .001$) predictor of child mortality both nationally and in the two rural RHDs (Northeast and Northwest). The results show that children born to mothers who are widowed or divorced are at a higher risk of dying than those born to mothers who are married or living together with their partners. The risk of dying before the age of five is also slightly relatively higher among children born to mothers who were never married compared to those born to mothers who are married or living together with their partners. This finding is interpreted as potentially signifying the importance of the family support system to safe- guard child survival and welfare.

Table 7.4: **Cox Model (Hazard Ratios = HR) for the effect of the predictor variables on the risk dying before the age of five: Namibia, Northeast RHD and Northwest RHD (level of significance, p ≤ .05)**

Equation Variable: Equation 1:							
Demographic factors	**Categories**	**Risk of dying before the age of five (HR)**					
		Namibia	SE	Northeast	SE	Northwest	SE
Mother's age at the time of interview	< 20	NS	-	NS	-	NS	-
	20-29	NS	-	NS	-	NS	-
	≥ 30 (ref.)	NS	-	NS	-	NS	-
Succeeding birth interval							
[time duration in months between the current birth (dead) and next birth]	< 24	2.06***	0.22	3.51***	0.49	3.46**	0.30
	≥ 24	1.00	-	1.00	-	1.00	-
Preceding birth interval							
(time duration in months between the current birth and previous birth)	< 24	NS	-	NS	-	NS	-
	≥ 24(ref)	NS	-	NS	-	NS	-
Parity (Number of children ever born)	1	0.54***	0.16	NS	-	NS	-
	2-3	0.78**	0.11	NS	-	NS	-
	≥ 4	1.00		NS	-	NS	-
Child's sex	Male	NS	-	NS	-	NS	-
	Female	NS	-	NS	-	NS	-
Equation Variable: Equation 2:							
Maternal and Child Health (MCH)							
Place of delivery	Homes	NS	-	NS	-	NS	-
	Public and Private health sectors (ref)	NS	-	NS	-	NS	-
Nutritional Status							
Child's birth weight (in kilograms)	< 2500	NS	-	1.45*	-	2.52*	0.26
	≥ 2500 (ref)	NS	-	1.00	-	1.00	-

***p < .001, **p < .01; *p ≤ 05; NS = not significant; ref = reference categories; SE = Standard Error

Table 7.5: **Cox Model (Hazard Ratios) for the effect of the predictor variables on the risk of dying before the age of five: Namibia, Northeast and Northwest RHDs (level of significance, p ≤ .05)**

Equation Variable: Equation 3:							
Household and environmental factors	**Categories**	**Risk of dying before the age of five**					
		Namibia	SE	Northeast	SE	Northwest	SE
4.1 Type of toilet facility (defined as (a) unsafe facility = bucket, no facility, bush, pit toilet, traditional pit latrine and	Unsafe facility	1.289*	0.12	2.64*	0.28	1.34*	0.36
(b) safe facility = flush toilet, pour flush toilet, ventilated improved pit latrine	Safe facility (ref)	1.00		1.00	-	1.00	-
4.2 Sex of household head	Male	ns	-	1.35*	0.25	NS	-
	Female (ref)	ns	-	1.00	-	NS	-
4.3 Household Wealth Index	Poor/ poorest	1.44*	0.23	NS	-	NS	-
	Middle	1.40*	0.21	NS	-	NS	-
	Rich/ Richest	1.00		NS	-	NS	-

Equation Variable: Equation 4:							
Socio-economic factors							
5.1 Highest level of education	No education	1.279*	0.19	2.66*	0.38	1.63*	0.30
	Primary	1.16*	0.16	1.90*	0.36	1.08*	0.50
	Secondary & Higher (ref)	1.00	-	1.00	-	1.00	-
5.2 Partner's highest level of education	No education	NS		NS	-	NS	
	Primary	NS		NS	-	NS	
	Secondary & Higher	NS		NS	-	NS	
5.3 Current marital status	Never married	0.34***	0.34	0.87*	0.43	0.34***	0.27
	Married	0.23***	0.28	0.58*	0.40	0.23***	0.31
	Living Together	0.33***	0.31	0.52*	0.40	0.33***	0.32
	Widowed/ Divorced	1.00		1.00		1.00	-

***p < .001, **p < .01; *p ≤ 05; NS = not significant; ref = reference categories, SE = Standard Error

Conclusion

The results suggest two urgent policy issues that need to be addressed to safeguard child survival in Namibia as well as in the Northeast and Northwest RHDs. The key issues to be addressed are shorter birth intervals and lower birth weight (LBW). As mentioned earlier, shorter birth intervals and the duration of breastfeeding are interrelated and mutually reinforcing. The death of an infant abruptly stops breastfeeding and may lead to an immediate pregnancy due to shortened postpartum amenorrhoea or deliberate replacement effect. Therefore, the findings are interpreted as supporting policy that encourages longer birth interval (beyond 2 years) and also require the strengthening of contraceptive use programs through broader programs of sexual and reproductive health.

LBW is another factor that features in both RHDs (Northeast and Northwest). The difference in weight at birth is determined by the physical condition of the mother rather than by the child's genetic makeup that becomes apparent only later in life. The problem of LBW is attributed to factors such as the ages of mothers and birth intervals. Other contributing factors are poverty, poor nutrition and infections such as malaria during pregnancy. This requires targeting intervention programs in both RHDs to address mothers' nutrition during pregnancy; ensuring that pregnant mothers receive essential micro-nutrition such as vitamin A, iodine and iron supplements. Seasonal malaria is prevalent in both the Northwest and the Northeast RHDs. Thus, there is a need to create awareness and strengthen malaria programs that distribute mosquito nets to pregnant mothers in the two RHDs.

In comparison to the Northwest RHD, variations of child survival by mother's level of education and toilet facility are quite prominent in the Northeast RHD. Subsequently, there is a need for targeted intervention programs addressing factors associated with low education enrolment and completion by young women in the Northeast RHD. These factors include among others; withdrawal of girls from school to take care of the sick and orphaned siblings in rural areas, favouring of boys' education more than girls, inability to pay school fees and teenage pregnancies.

It has been widely assumed that male-headed households have a stronger resource base than female-headed households. Yet, there have also been arguments that decomposed household income does not capture widespread and systematic inequalities within households that are related to age, life cycle status, relationship to household head and others, though Kabeer (2003) emphasises that the most pervasive are those related to gender. Female-headed households were often found to have greater autonomy and control over resources, and outcomes of women and children's health were in some cases better than in male households with the same level of income. This argument seems consistent with the findings in the Northeast RHD, where male-headed households were associated with a high risk of dying before the age of five. Consequently, there is a need for studies to research on the issue of equitable intra-households distribution of resources and the root causes of possible emerging trends of poverty among male-headed households in the Northeast RHD.

The results show that marital status is significantly associated with child mortality ($p < 001$) at the National level as well as in the two rural RHDs (Northeast and Northwest). This finding is viewed as a surprise and probably unique to Namibia as the variable did not feature in any of the reviewed studies conducted in other Sub-Saharan countries (Imam & Koch, 2004 in a Sub-Saharan Africa study; Mwale, 2004 in Malawi, Kembo & Ginneken, 2009 in Zimbabwe). The results underscore the need for strengthening programmes that support orphans and vulnerable children (OVC) as well as male involvement programmes on sexual and reproductive health.

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