Child Mortality and Morbidity in South Sudan

[1]M. D. Shehu, [2]I. A. Nafiu[3], K. M. Latjor and [4]H. O. Ahmed
[1, 2]Department of Mathematics, Federal University of Technology, Minna, Nigeria
[1]m.shehu@futminna.edu.ng and [2]ojoneahmed86@yahoo.com
[3]Department of Mathematics and Statistics, Islamic University in Uganda, Mbale, Uganda
ianafiu@iuiu.ac.ug
[4]National Bureau of Statistics, South Sudan
kelmalual2@yahoo.com

Abstract
This study examines factors associated with childhood mortality and morbidity in South Sudan. The specific objectives were to establish childhood mortality, examine the effect of childhood factors on morbidity and assess the contribution of mother factors on childhood mortality and morbidity. Data from Second South Sudan Household Health Survey (SSHHS2) were used and univariate, bivariate, logistic regression and nested logistic models were used to estimate the odds of dying and survivorship probabilities for under-five mortality. The results provide estimates of childhood mortality by bio-demographic, socio economic characteristics, residence, state level, unexpected pattern for infant and under five mortality rates across residence, mother education and wealth quintiles. It was found that education of the mother has a weak relationship with the overall level of child mortality and birth interval affects survival when there is an interval of less than two years between pregnancies, demonstrating the importance of spacing on child survival. Thus, it was recommended that government of South Sudan in conjunction with NGOs should implement effective educational programmes that aim at promoting and prolonging breastfeeding and mass immunization as effective ways of increasing child-birth intervals and reducing prevalence of immunisable diseases.

Keywords: Child birth, intervals, immunization, childhood, mother and factors

Introduction

One of the demographic variables that affect population trends and of interest to demographers, policy makers and researchers is mortality because it is an indicator of socio-economic development (Mosley and Chen, 1991). World Health Organization (2005) reported that 10.8 million children under age five die every year. According to UNICEF (2006), the decline in child mortality in Africa has been slower since 1980 than in the 1960s and 1970s. Despite the improvements in the health and well-being of populations globally over the last few decades, factors such as infectious and parasitic diseases and malnutrition persist as the major obstacles to reduction in child mortality in many developing countries (Aguirre, 1995). Of the thirty countries with the world's highest child mortality rates, twenty-seven are in sub-Saharan Africa. Child mortality and morbidity both have a great impact on the development of any society. Morbidity, which is the rate of incidence of a disease, or the number of times people suffer from a disease in a given locality, exerts a heavy price on families and communities. From birth to two years, morbidity can have a long-term impact on a child's cognitive and physical development (World Health Organization, 2005). Therefore, disentangling the effects of environmental and socio demographic risk factors of mortality could lead to a better understanding of the forces underlying childhood mortality and help child survival intervention program managers to prioritize and target children who are at most risk (Binka *et al.*, 2007). This study thus focuses on determinants of child mortality and morbidity which include breastfeeding, age of mother at child's birth, vaccination, maternal education, Birth spacing and socio-economic conditions.

Literature Review

Research on determinants of childhood mortality and morbidity has dominated the field of demography and population studies since the 1960s through to the 1990s (Kaldewei and Pitterle,

2011). Nevertheless, the 1980s and 1990s ushered in a new perspective towards the study of childhood mortality as it was a time to take seriously the intertwined nature of child mortality with other issues such as poverty, inequality and gender disparities (Gakidou *et al.*, 2010). Desai & Alva (1998) further argued that from the 1980s up to date, there has been a transformation and efforts are constantly being made to acknowledge the important role played by other determinants of child mortality. Similarly, Croghan *et al.* (2006) cited important factors such as "strong economy, education, adequate nutrition, equity, and effective government; a functioning public health system that provides sanitation, clean water, and infection control; and a comprehensive primary health care delivery system" that are required to address Millennium development goals (MDGs) especially child mortality. Since renewed global commitments in 2000 to reduce childhood mortality by two-thirds between 1990 and 2015 and to address other developmental goals, there has been another notable decrease in the levels of childhood mortality world-wide, although at a slower rate than anticipated (Walker *et al.*, 2002). According to Black *et al.* (2003), the absolute number of children dying had come down to 10.8 million child deaths worldwide.

Schultz (1984) focused on the determinants of individual and household morbidity and mortality in order to inform policies designed to reduce the burden of disease. The socioeconomic determinants of morbidity outcomes such as maternal education, household income and access to health were examined. Mortality and fertility affect each other in many ways – both directly and indirectly. It is reasonable to assume that parents care about the number of surviving children and not how many that are born. Child mortality in a household, i.e. the probability of a child passing away, will therefore affect the number of births required to reach the desired number of surviving children. This can be said to be an indirect effect of mortality on fertility; the probability of a child dying affects the household demand for children (National Bureau of Statistics and Ministry of Health, 2010). Therefore, this study examines factors associated with childhood mortality and morbidity in South Sudan.

3. Materials and Methods

In this study,

Infant Mortality Rate is the probability of dying between 0-12 months of life and is expressed as deaths per 1000 live births.

Under-five mortality rate is the probability of dying between birth and exact age 5.

Determinants of mortality refer to the factors likely to have an influence on mortality.

Mortality is the condition of one day having to die or the rate of failure or loss.

Morbidity as a term is used to describe how often a disease occurs in a specific area or is a term used to describe a focus on death.

Logistic regression model

Logistic regression analysis belongs to a family of multivariate regression methods that are used to establish existing relationships between and among variables. According to (Reid, 1987) measuring of existing relationships or associations between and among variables is important in the field of social statistics as it helps with the formulation of theories and hypotheses. Logistic regression measure association between variables and it is methods which accommodate dependent variables with categorical outcomes (Rutherford *et al.*, 2010). Logistic regression can be used to estimate likelihoods, probabilities, odds and log-odds of an event occurring (Rutherford *et al.*, 2010).

For this study logistic regression was used to estimate the odds of an event happening and was presented as odds ratios. These odds ratios produced with logistic regression analysis indicated the association that is likely to occur with dichotomous outcomes, in case of this study whether

the child was still alive or dead at the time of the survey. Since the outcome variable was a two-category dependent variable, binary logistic regression was the most appropriate method for this study (Rutherford *et al.*, 2010, Marsh and Elliott, 2008). Where 0 was children alive and children dead were coded 1. The purpose of the analysis using logistic regression analysis is to assess the effects of multiple explanatory variables on the outcome variable. Logistic regression method of analysis involves the construction of models or logits that predict the odds of an event occurring. In this analysis the dependent variable is binary of nature since there are two different outcomes; a child either survives or dies as mentioned earlier. Thus, a logistic regression model was applied for the statistical analysis. It was used in the study to estimate the likelihood of child survival in view of the prevailing socio-economic and demographic as well as biological factors in the mortality regions. It was used to determine the relationship between selected independent variables and child death. The P-value selected is 0.05 implying that any observed significance which was less than P-value implied an association between the dependence and independent variables, while P-value above 0.05 was taken as indicating no association between the variables.

The equation for predicting the probability of an event occurring using logistic regression analysis when investigating the effects of one independent variable is as follow.

$$\text{Log}\left[\frac{Pi}{1-Pi}\right] \quad logoi = \alpha + \beta X \tag{1}$$

where 1 is the probability of being alive and Pi is the proportion of dying, $log0i$ is the odds of an event occurring and $\boldsymbol{\alpha+\beta X}$ is the effects of one independent variable before controlling for other factors. The formula that involves independent variables therefore becomes

$$\log\left[\frac{\text{Pi}}{1-\text{Pi}}\right] = \alpha + \beta_1 \text{X}_{i1} + \beta_2 \text{X}_{i2} + \cdots + \beta_p X_{\text{ip}} \tag{2}$$

Where $1-Pi$ represent the conditional probability of being alive; Pi is the proportion dying.X_{i1} , X_{i2}+…..X_{ip}, are the independent variables, β_1 , β_2….β_3 are the slope coefficients. In order for interpretation of logistic regression using odds, antilog were applied to equation (2) to have the model as equation (3);

$$\frac{\text{Pi}}{1-\text{Pi}} = \text{e}^{\alpha+\beta} = e^{\alpha}\left(e^{\beta}\right)^{X} \tag{3}$$

where the two constants multiplied by each other raised to the power X imply that an additional explanatory variable added on to the regression has a multiplicative effect on the odds of dying. For this study three models were nested. The models were labeled as model I, which investigated the effects of bio- demographic factors which are age of mother and gender of child. In model II, socio-economic factors that have been known to impact on the survival of children that include maternal education and household socio-economic status are introduced. And model III introduced geographical variables which are area of residence (rural or urban and state of residence to the equation.

Logistic regression was used to estimate the odds ratios. These odds ratios produced with logistic regression analysis indicated the association that is likely to occur with dichotomous outcomes, in case of this study whether the child was still alive or dead at the time of the survey. It was used in the study to estimate the likelihood of child survival in view of the prevailing socio-economic and demographic as well as biological factors in the mortality regions. It was used to determine the relationship between selected independent variables and child death. The P-value selected is 0.05 implying that any observed significance which was less than P-value implied an association between the dependence and independent variables, while P-value above 0.05 was taken as indicating no association between the variables. For this study three models were nested. The models were labeled as model I, which investigated the effects of bio- demographic factors which are age of mother and gender of child. In model II socio-economic factors that have been known to impact on the survival of children that include maternal education and household socio-

economic status are introduced. And model III introduced geographical variables which are area of residence (rural or urban and state of residence to the equation. For this study the dependent variable was status of child whether dead or alive at the time preceding the survey, indicating that the dependent variable had binary outcome. For this study a number of independent variables were of interest and they included bio demographic factors, socio-economic factors and Geographical factors such as Residence.

Results

Table 1: Childhood mortality by by bio-demographic characteristics

	Neonatal mortality rate	Post neonatal mortality rate	Infant mortality rate	Child mortality rate	Under five mortality rate
Sex of child					
Male	46	38	84	36	117
Female	39	34	3	29	99
Mothers age at birth					
< 20 years	34	38	72	20	91
20 - 34 years	37	30	67	31	96
35 - 49 years	75	59	134	56	188
Birth order					
1	31	31	63	22	83
2-3	26	26	52	26	76
4-6	44	42	86	34	117
7+	107	54	161	91	238
Previous birth interval					
< 2 years	87	60	147	49	188
2 years	34	26	60	31	89
3 years	21	26	47	27	72
4 + years	29	31	60	26	84

The results show an unexpected pattern for infant and under-five mortality rates across residence, mother's education and economic status. The two childhood mortality indicators are higher in urban areas, primary education and richest households. The findings further reveal that under-five mortality rate is estimated at 107 deaths per 1000 live births for children whose mothers have no education and at 118 deaths per 1,000 live births for mothers with primary education. For children, whose mothers have no education, infant mortality rate is estimated at 78 deaths per 1000 live births, and at 82 deaths per 1000 live births for children whose mothers have primary education. Significant variations are also noted between middle and richest quintiles.

Table 2: Prevalence of Vaccination in South Sudan

Type of vaccination	Vaccinated by 12 months of age
BCG [1]	31.4
Polio 0	18.4
Polio 1	34.7
Polio 2	20.9
Polio 3 [2]	12.7
DPT/HepB/INL1	24.9
DPT/HEPB/INFL2	20.4
DPT/HepB/INF3[3]	13.1
Measles [4]	20.4
All Vaccinations	6
No Vaccinations	45.9

The results indicate that the vaccination schedule followed by the South Sudan National Immunization Programme provides only BCG and DPT (against Diphtheria, tetanus and whooping cough). The percentage of children aged 12 to 23 months who have received each of the specific vaccinations by source of information (vaccination card and mother's recall). Approximately 31 percent of children aged 12-23 months received a BCG vaccination by the age of 12 months and the first dose of DPT was given to 25 percent. The percentage declines for subsequent doses of DPT to 20 percent for the second dose and the 13 percent for the third dose. Similarly, 35 percent of children received Polio 1 by age 12 months, and this declines to 13 percent for the third dose. The coverage for measles vaccine by 12 months is 20 percent. The proportion of children who received all vaccinations is very low at 6 percent, while those who did not receive any vaccinations is 46 percent.

Table 3: Summary of the Mother factors on mortality

	Chi-square	two-sided P-value	Cramer's V	Phi
Mothers age at birth	4.677621027	0.791410893	0.047837896	0.067653001
Birth order	11.34676708	0.056094878	0.097159179	83
Previous birth interval	5.495320923	0.78917131	0.042315364	0.073292361
State	31.39130961	0.255377029	0.064058092	0.11095187
Residence	1.173250383	0.759426862	0.04709421	0.04709421
Education	0.647127954	0.885563715	0.035075366	0.035075366
Wealth index quintile	3.783578011	0.987032538	0.031451085	0.054474876

The data reveals that there exists a relatively strong positive relationship between birth order and the overall level of child mortality in South Sudan. A birth order of 7+ is linked with relatively high infant mortality rate recording the highest figure for the under-five mortality rate category. The results also indicate that as the birth order increases, the rate of infant mortality increases as well. The education of the mother has got a very poor relationship with the level of child mortality in the country since it was associated with a very negligible Pearson Chi-square value. The previous birth interval variable produced a relatively strong relationship with the overall rate of mortality in the country. The results indicate that lower birth intervals are associated with lower infant mortality rates and the figure for infant mortality rate reduces as the birth interval increases recording the lowest figure for 4+ years' category of birth interval. Furthermore, the states where the mothers of these children live have also got a positive impact on the overall level of infant mortality.

Discussion of Findings

The result from the study, indicate that births order seven and over experience the highest levels of childhood mortality, while childhood mortality is lowest for second and third order births. The birth interval also affects survival when there is an interval of less than two years between pregnancies, demonstrating the importance of spacing on child survival. This is fairly consistent in all childhood mortality indicators. The results further provided estimates of childhood mortality by state, residence and socio economic characteristics. State of residence played an important role in the survival of children under age of 5. Children residing in 7 of the country's 10 states were less likely to die compared to the Eastern Equatoria reference state. The results showed that the odds against dying for children born in the household with poorest second, middle, and Fourth wealth quintiles compared to the richest wealth quintiles. It was observed from the results that all the probabilities were not significant as they were associated with very high P- value. The findings further indicated vaccination schedule followed by the South Sudan National Immunization Programme provided only BCG and DPT (against Diphtheria, tetanus and whooping cough). Oral polio vaccine and measles are used for routine infant immunization schedule. Taking into consideration this vaccination schedule, the estimates for full immunization coverage from the South Sudan Household Health Survey are based on children aged 12-23 months. The proportion of children who received all vaccinations is very low than those who

didn't receive any vaccinations. The results revealed that there existed a relatively strong positive relationship between birth order and the overall level of child mortality in South Sudan. A birth order 7+ is linked with relatively high infant mortality rate recording the highest figure for the under-five mortality rate category. The results also indicate that as the birth order increases, the rate of infant mortality increases as well. Additionally, the education of the mother has got a very poor relationship with the overall level of child mortality in the country since it was associated with a very negligible Pearson Chi-square value.

The previous birth interval produced a relatively strong relationship with the overall rate of mortality in the country. The findings indicated that lower birth intervals are associated with lower infant mortality rates and the figure for infant mortality rate reduces as the birth interval increases recording the lowest figure for 4+ years' category of birth interval.

Conclusions

The findings suggested that childhood mortality was not associated with age of the mother, mother's education, wealth index quintiles, residence and state of residence. There may be other factors which affect childhood mortality. The birth interval also affects survival when there is an interval of less than two years between pregnancies, demonstrating the importance of spacing on child survival. The greatest childhood contributor to mortality and morbidity risk is diarrhea because a large number of males and females that took part in the survey had diarrhea at least in the previous weeks prior to the study. Breast feeding, malaria infections were also great contributors to morbidity since they presented infection figures that were significant enough in the study. The results concluded that previous birth interval produced a relatively strong relationship with the overall rate of mortality in the country. The findings further indicated that lower birth intervals were associated with lower infant mortality rates. Birth interval remains an issue that deserves urgent attention in South Sudan.

Recommendations

Further study should be conducted to look into causal pathways as well as strategies to improve spacing between pregnancies whilst efforts to prevent adverse pregnancy outcomes, an important determinant of birth spacing, should be identified. In order to avoid prevalence of malaria, diarrhea and pneumonia in infants and under 5, the government of South Sudan in conjunction with NGOs should implement effective educational programmes that aim at promoting and prolonging breastfeeding that may have a considerable effect on child survival as well as to carry out full immunization programmes that cover both urban and rural areas in South Sudan.Mother needed to be exposed in order to alleviate the health of their young ones and themselves.

References

Binka, F.; Palloni, A.; Tienda, M. & Dan, D. (2007). Rapid achievement of the child survival millennium development goal: evidence from the Navrongo experiment in Northern Ghana. *Tropical Medicine & International Health*.578–583

Black, E., Morris, S. & Bryce, J. (2003). Where and why are 10 million children dying every year? *The Lancet*, 361, 2226-2234.

Croghan, T., Beatty, A. & Ron, A. (2006). Routes to better health for children in four developing countries. *Milbank Quarterly*, 84, 333-358

Desai, S. & Alva, S. (1998). Maternal education and child health: Is there a strong causal relationship? *Demography*, 35, 71-81.

Gakidou, E., Cowling, K., Lozano, R. & Murray, C. (2010). Increased educational attainment and its effect on child mortality in 175 countries between 1970 and 2009: a systematic analysis. *The Lancet*, 376, 959-974.

Kaldewei, C. & Pitterle, I. (2011). Behavioural Factors as Emerging Main Determinants of Child Mortality in Middle-Income Countries: A Case Study of Jordan.

Marsh, C. & Elliott, J. (2008). Exploring Data: An Introduction to Data Analysis for Social Scientists, MA, Polity.

National Bureau of Statistics and Ministry of Health. (2010). Monitoring the Situation of Children and Women in South Sudan. South Sudan Household Survey 2010. Final Report, Juba, South Sudan.

Reid, S. (1987). *Working with statistics: An introduction to quantitative methods for social scientists*, Cambridge, Polity Press.

Rutherford, M., Mulholland, K. & Hill, P. (2010). How access to health care relates to under-five mortality in sub-Saharan Africa: systematic review. *Tropical Medicine & International Health*, 15, 508-519.

Schultz, T. (1984). Studying the impact of household economic and community variables on child mortality. *Population and Development Review*, 10, 215-235.

UNICEF (2012). The State of The World's Children. www.unicef.org/sowc2012/.../SOWC%202012-Main%20Report_EN_13Mar20...

Walker, N.; Schwartländer, B. & Bryce, J. (2002). Meeting International Goals In Child Survival and HIV/AIDS. *The Lancet*, 360, 284-289.

World Health Organization (2005). The World Health Report 2005 - Make Every Mother and Child Count. *World Health Organization Review*