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Does place of delivery affect neonatal mortality in Rufiji Tanzania?

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DECLARATION

I, Justice Ajaari hereby declare that this research report work is my own work. It is being submitted for the degree of Master of Science in Medicine in the field of Population Based Field Epidemiology in the School of Public Health of the University of the Witwatersrand, Johannesburg, South Africa.

This research report has not been submitted before for any degree or examination at this or any other University.

Signature: ……

Full Name: Justice Ajaari

10th day of November, 2008

DEDICATION

This work is dedicated to the omnipotent, omnipresent and omniscient God for his protection, guidance and blessings that have brought me to this level of my education and career.

This work is also dedicated to all my family members, well wishers and all those who have supported and encouraged me through out my life.

ABSTRACT

Introduction

The fourth Millennium Development Goal (MDG) calls for a reduction in newborn mortality but newborn mortality is one of the world's most neglected health problems. While there has been significant progress in reducing deaths among children under age five over the past decade, the proportion of under five mortality that occur in the neonatal period, an estimated 38% in 2000, is increasing. Therefore the Millennium Development Goal for child survival cannot be met without substantial reductions in neonatal mortality. It is therefore extremely important to make available the much needed epidemiological information regarding the time, place and causes of neonatal deaths which will enable greater attention to policies aimed at reducing levels of mortality and programme planning.

Objectives

The objective of this study was to investigate the relationship between neonatal mortality and place of delivery in Rufiji in rural Tanzania. The specific objectives were: 1.to measure and compare the neonatal mortality rates among neonates born in and outside health facilities, 2. to compare the maternal characteristics of those who deliver in and outside health facilities, 3. to compare cause-specific neonatal mortality among neonates born in and outside health facilities and 4.to measure the association between place of delivery and neonatal mortality.

Methods

Data from the Rufiji Demographic Surveillance System (RDSS), Tanzania, was used for the analysis. A total of 5124 live births and 166 neonatal deaths were recorded from 1st January, 2005 to 31st December, 2006.

Place of delivery and place of death were categorized as either health facility or outside health facility. Neonatal mortality rates were calculated by dividing the number of neonatal deaths to the total number of live births and multiplied by 1000.

Data on causes of death were collected using verbal autopsies. Cause specific mortality was determined by using physician coding according to a list of causes of death based on the 10^{th} revision of International Classification of Diseases. Household characteristics and assets ownership of the mothers of the neonates were used to construct a wealth index as proposed by Filmer and Pritchett in 2001[1]. The index was calculated using Principal Component Analysis (PCA) in Stata version 10 software. A chi-square (x^2) test at 5% significant level was also used to compare the maternal characteristics by place of delivery and neonatal characteristics and place of delivery. Univariate and multivariate logistic regression models were also used to assess the association between neonatal mortality and place of delivery as well as between neonatal mortality and maternal risk factors, while adjusting for potential confounders.

Results

The highest number of neonatal deaths occurred during the first week of life 111(67%), the remainder occurred from the second week to the fourth weeks of life 55(33%). The overall neonatal mortality rate was 32/1000 live births. Neonatal mortality rate was higher in children born outside heath facilities 43/1000 live births compared with those born in health facilities 27/1000 live births. The two major causes of deaths in both health facility deliveries and outside health facility deliveries were birth injury or asphyxia n=29 (26%) and prematurity/low birth weight n=25 (22%). Mothers who delivered out-side a health facility were 1.6 times more likely to have experienced neonatal death [unadjusted OR=1.6, p-value = 0.002, 95% CI 1.2, 2.2] compared to mothers who delivered in health facility and this was statistically significant. After

adjusting for maternal risk factors, mothers who delivered outside a health facility were 1.7 times more likely to have experienced neonatal death [adjusted OR=1.7, p-value = 0.002, 95% CI 1.2, 2.4] compared to mothers who delivered in a health facility and this was statistically significant. Maternal household socio-economic status and parity were the only other factors that were found to be statistically significantly associated with neonatal mortality in the multivariate analysis. For instance, least poor mothers were found to be 40% less likely to have experienced neonatal death [adjusted OR = 0.6, p-value = 0.046, 95% CI 0.4, 1.1] compared to the poorest mothers and this was statistically significant. Less poor mothers were also found to be 50% less likely to experience neonatal mortality [adjusted OR =0.5, p-value = 0.002, 95% CI 0.3, 0.8] compared to the poorest mothers. Mothers who had parity of three to four (3-4) were found to be 40% less likely to have experienced neonatal death compared to mothers who had parity of one to two (1-2). Mothers who had parity of five (5) and above were also found to be 50% less likely to have experienced neonatal death compared to those who had parity of one to two (1-2).

Conclusion

Place of delivery has a very important role in neonatal survival in this rural setting. In order to reduce neonatal mortality, pregnant women should be encouraged and supported to give birth to their newborns in a health facility while discouraging deliveries that occurred outside health facility. Infrastructure, such as emergency transport, to facilitate health facility deliveries requires attention.

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Definition of Key Terms

1. Neonatal mortality: This refers to deaths in infants under 29 days of age.
2. Early Neonatal Mortality: This refers to deaths in children in the first week of life.
3. Late Neonatal Mortality: This refers to deaths in children between 8 to 28 days.
4. Perinatal mortality: This refers to stillbirths and deaths in the first week of life.
5. Infant mortality: This refers to deaths in children less than one year old.
6. Child mortality: This refers to deaths in children between one and four years old.
7. Under five mortality: This refers to deaths in children less than five years old.
8. Verbal autopsy: A procedure for gathering systematic information that enables a determination to be made of the cause of death in situations where the deceased has not been medically attended. It is based on the assumption that most common and important causes of death have distinct symptom complexes that can be recognized, remembered, and reported by lay respondents. It is a useful way to enhance the quality of mortality statistics in developing countries[2].
9. Health Facility: This refers to ministry health approved centres with trained and qualified health workers such as Clinics, Hospitals, Health Post, Maternity homes, etc.
10. Skilled Attendants: This refers to individuals who have been trained by a qualified health worker and given permission to attend to deliveries.
11. Place of delivery: This refers to the place where a birth or delivery takes place irrespective of the person who attended to the delivery, either home, on the way, in a health facility, at traditional healer, church, etc.

12. Demographic Surveillance System (DSS): This is a set of field and computing operations to handle the longitudinal follow-up of well-defined entities or primary subjects (individuals, households, and residential units) and all related demographic and health outcomes within a clearly circumscribed geographic area (INDEPTH Network)[3].

13. Household: This is a social group of one or more individual members who are usually related.

Abbreviations and Acronyms

AIDS	Acquired Immune Deficiency Syndrome
HIV	Human Immuno-Deficiency Virus
DSS	Demographic Surveillance System
PCA	Principal Component Analysis
DSA	Demographic Surveillance Area
RDSS	Rufiji Demographic Surveillance System
VA	Verbal autopsy
WHO	World Health Organization
UNFPA	United Nations on Population Fund
RDSA	Rufiji Demographic Surveillance Area
DHS	Demographic and Health Survey
AMMP	Adult Morbidity and Mortality Project
TEHIP	Tanzania Essential Health Interventions Project
UNICEF	United Nations Children Fund
MGD	Millennium Development Goals
INDEPTH	International Network for Continuous Demographic Evaluation of Populations and Their impact on Health in Developing Countries

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Chapter One: Introduction and Literature Review

1.0 Introduction and Background

The fourth Millennium Development Goal (MDG) calls for a reduction in newborn mortality but newborn mortality is one of the world's most neglected health problems[4]. While there has been significant progress in reducing deaths among children under age five over the past decade[4], the proportion of under five mortality that occur in the neonatal period, an estimated 38% in 2000 is increasing[5]. Therefore the Millennium Development Goal for child survival cannot be met without substantial reductions in neonatal mortality[5]. According to the United Nations Children's Fund (UNICEF) 2008 report on the state of the world's children, in 2006, for the first time in recent history, the total number of annual deaths among children under the age of five fell below 10 million, to 9.7 million which represents a 60% drop in the rate of child mortality since 1960[6]. But every year an estimated 4million babies die in the first 4 weeks of life (the neonatal period). Three-quarters of neonatal deaths happen in the first week, the highest risk of death is on the first day of life[5]. As many as 99% of the 4 million neonatal deaths that occur each year take place in the poorest countries of the world. This is double the deaths that are caused by HIV/AIDS[5,7].These figures become even more worrisome when one considers that for every early neonatal death, ~1 stillbirth also occurs[5,7] making perinatal deaths responsible for ~7% of the total global burden of disease[5,8].This proportion exceeds that caused by vaccine-preventable diseases and malaria together[5,9]. The risk of death in the neonatal period is six times greater in developing countries than in developed countries and in the least developed countries it is over eight times higher. With 41 neonatal deaths per 1000 live births, the risk of neonatal death is highest in Africa; the sub-Saharan regions of Eastern, Western and Central Africa have between 42 and 49 neonatal deaths per 1000 live births[10].

Babies born in Tanzania as with most developing countries are at higher risk of death in the neonatal period. Among the countries with the highest newborn deaths in the world, Tanzania is ranked tenth (10^{th})[4]. The 2004-2005 Tanzania Demographic and Health Survey (TDHS) results show that the perinatal mortality rate for the entire country is 42 deaths/1000 pregnancies[11]. However, in developing countries, just over 40% of deliveries occur in health facilities and little more than one in two takes place with the assistance of a doctor, midwife or qualified nurse[8, 12]. Other studies have also shown that 63% of neonates in developing countries, with up to 83% in rural India, are born at home[13,14].Meanwhile, neonatal care is not available to most neonates in developing countries because hospitals are inaccessible and costly[15] and literature on the effect of place of delivery on neonatal mortality in a rural setting in sub-Saharan Africa is very limited. Research or interventions targeting neonates is also virtually absent in most developing countries and Tanzania is no exception. Furthermore, vital registration is generally lacking in infrastructurally weak areas such as Tanzania and most rural Africa where health and development problems are often most pressing. Health and demographic surveillance is a response to the lack of a valid longitudinal information base that can provide high quality longitudinal data on population dynamics, health and social change to inform policy and practice[16]. For instance, in spite of the importance of data on birth outcomes for planning maternal and child health care services, accurate indices especially from developing countries are quite difficult to obtain. For example, there are big variations in estimates of perinatal mortality in Tanzania ranging from a minimum estimate of 27 to as high as 125/1000 births across different regions in the country[17, 18, 19, 20 , 21, 22]. A hospital based study in Kilimanjaro found neonatal mortality to account for two thirds of infant mortality[23], while some studies about neonatal mortality in the country have rates ranging from 19/1000 live births to 69/1000 live

births[17,18 , 24]. Meanwhile, community and population based information on neonatal mortality and place of delivery in Tanzania is very limited and in sub Saharan Africa, it is generally lacking with most neonatal deaths going unaccounted for.

The achievement of the Millennium Development Goal for newborn survival will therefore not be met in Tanzania and sub-Saharan Africa without the needed population based information on the effect of place of delivery on neonatal mortality for proper planning and development of interventions. Moreover, since most neonatal deaths occur at home or outside of health facilities, we cannot rely on conventional, health facility-based and/or health management information systems attendance data as the source of information on the burden of disease experience by communities and households. Instead we can use household derived demographic surveillance data from the national sentinel surveillance system for understanding the real burden and its trends in various parts of Tanzania[25].

This study therefore aims to contribute to the limited knowledge on the effect of place of delivery on neonatal mortality from a rural perspective and contribute to the realization of the Millennium Development Goal for newborn survival.

1.1. Causes of Neonatal Mortality

Globally, the main direct causes of neonatal death are preterm birth (28%), severe infections (26%), and asphyxia (23%). Neonatal tetanus accounts for a smaller proportion of deaths (7%), but is easily preventable. Low birth weight is an important indirect cause of death. Maternal complications in labour carry a high risk of neonatal death, and poverty is strongly associated with an increased risk[5].

Currently, most newborn deaths in developing country communities are due to failure to:(1) identify and address socioeconomic, cultural and logistical barriers to proper maternal and newborn care and care seeking; (2) implement basic preventive measures

(e.g., administration of tetanus toxoid, early exclusive breastfeeding); and, (3) promptly identify and manage sick newborns[9]. A study in Nigeria reported that, birth asphyxia was most common in the study group of (outside health facility deliveries) (n=48 (14.3%)) compared to the control group of (health facility deliveries) (n=16 (4.8%)). This difference was statistically significant (P<0.001). The study also revealed that, neonatal infection/tetanus was also significantly more common in the study group n=22 (6.5%) than in the control group n=8 (2.4%)) (P<0.01). A further analysis showed that three of the babies in the study group had neonatal tetanus but none in the control group. There was a statistically significant difference in birth trauma between the study group n=10 (3.0%) and the control group n=2 (0.6%) (P<0.05)[26].

However, a study in Mwanza in Tanzania reported that place of delivery was not significantly associated with infection[27]. In another study in rural northern Tanzania, the distribution of causes of death was fairly similar among deaths occurring at home and at health facilities (P= 0.16). 54% of the infection-related cases and 36% of the asphyxia related cases had been born at home, compared with 44% and 50% in a health facility (P= 0.3). 44% of the infection-related cases and 33% of the asphyxia related cases died at home, compared with 46% and 53% at a health facility (P= 0.4)[28].

1.2. Place of Delivery and Neonatal Mortality

Skilled attendance and institutional delivery rates are lowest in countries with the highest neonatal mortality rates (NMRs)[5]. Children delivered at a medical facility are likely to experience lower mortality than children delivered at home because such facilities usually provide a sanitary environment and medically correct birth assistance[29].

In Tanzania, 53% of all deliveries take place in the home[30, 31] and only 36% of births are attended by skilled health personnel[17]. However, in the Rufiji Demographic

Surveillance area (RDSA), over 60% of births occur in health facilities and about 35% at home[25]. A study in Tanzania reported that perinatal mortality in home births delivered without a trained attendant was three times higher than that for births in a hospital or dispensary with trained attendants[32]. Another study in Papua New Guinea found a high rate of obstetric complications amongst apparently normal pregnancies delivering at home[33]. In study from Hlabisa health district in rural South Africa, most neonatal deaths occurred within the district hospital whereas, in a population-based study in rural Gambia, 84% of neonatal deaths occurred at home[34, 35].

A study of neonatal mortality by place of delivery in Sao Paulo showed that children who were not born in a hospital (health facility) had an increased risk of neonatal mortality(odds ratio 1.93 with 95% confidence interval 1.02, 3.63; x^2 =4.88;p< 0.003)[36]. However, a recent study in Tanzania, from the Kilimanjaro region indicated that >40% of perinatal deaths occurred at home[37]. A study in Nigeria reported that, eighteen babies in the study group (outside health facility delivery) died during the study, giving a perinatal mortality rate of 54/1000 births while six babies died in the control (health facility delivery) with a perinatal mortality ratio of 189/1000 births. This difference was statistically significant (P<0.05). According to the Nigeria study the risk of perinatal loss in booked women (i.e. woman who made arrangement in advance to give birth in a health facility) when labour is conducted outside the health facilities is three times higher than when conducted at a health facility[26]. An eight year study in Ghana showed that, majority (86%) of deaths occurred at home, with only 141(13%) occurring at the health facility. The study also showed that most (63%) deaths occurred in the early neonatal period. The study concluded that neonatal mortality could be reduced by preventing and treating neonatal infections, having skilled attendance at delivery and the elimination of infanticide[38]. Another study in rural northern Tanzania reported that,

Forty-eight percent of all the babies that died were born at home and 38% of the babies died at home and 84 babies died at or on the way to a health facility[28]. However, most women who deliver their children at a medical facility in developing countries tend to enjoy a high socioeconomic status. Poor women tend to only deliver their children in a medical facility if they anticipate a complication[29]

1.3. Maternal Characteristics and Neonatal Mortality

1.3.1. Maternal Education

The relationship between maternal education and perinatal and neonatal mortality is complex but several studies have demonstrated reduced rates of infant and child mortality in association with increased levels of maternal education[39,40]. This association is partly explained by the economic advantages and access to health care afforded by education. Potential links between maternal education and reduced perinatal and neonatal mortality also include appropriate birth spacing and health-seeking behaviour, particularly for prenatal care. Infants born to mothers who do not receive prenatal cares have nearly a 25% increase in neonatal mortality, and the risk of perinatal mortality is highest in women with very short and very long intervals between pregnancies[41]. According to Save the Children's 2004 report on State of the World's Mothers, uneducated mothers are at a severe disadvantage, as are their babies. The report states that, mothers who missed out on schooling are more likely to be poor, to get pregnant younger and more often, to have higher rates of newborn and maternal mortality, to be less knowledgeable about family planning and HIV prevention, and to be less prepared to look after the health and well-being of their babies[42].

Other studies have also shown that mothers with less education are less likely to receive skilled medical care during pregnancy and childbirth. In Egypt, for example, only 33% of women with no education receive any prenatal care, and only 17% receive regular

prenatal care, while 75% of women with secondary or higher education receive prenatal care and 60% receive regular care[43]. And in Nigeria, only 15% of births among uneducated women are assisted by trained medical personnel, compared to 56%, 74% and 88% of births among women with primary, secondary and higher education, respectively[44]. Babies born to mothers with little or no education are at greater risk during birth, during the vulnerable early days, and throughout their lives. According to data from 35 demographic and health surveys, children of mothers with no education are more than twice as likely to die or to be malnourished than children of mothers who have secondary education or higher, even when controlling for other factors[45]. However, other maternal factors may play a role. A study in Sao Paulo in Brazil, found that poor education of household head (OR=1.6; 95% CI: 1.1; 2.6), mothers in recent union (OR=2.0; 95% CI: 1.0; 4.2), unmarried mothers (OR=1.8; 95% CI: 1.1; 3.0) were risk factors for early neonatal mortality[46].

1.3.2. Maternal Age

Children born to mothers under 20 or over 30 years old are likely to have elevated risks of mortality. Studies have showed that neonatal mortality is lowest among children born to mothers age 20-30 and is much higher for very young and very old mothers[29].

A study investigating causes of perinatal mortality by verbal autopsy in Maharashtra, India, reported that, age of a mother at pregnancy was an important factor contributing to perinatal mortality[47]. According to the study, babies born with mothers at age less than 25 years were found less likely to survive as compared to mothers at higher age. The study reported that 64(77%) of the perinatal deaths occurred in mothers having age at pregnancy less than 25 years and 52% of the stillbirths were found in mothers having less than 21 years of age, which indicates that mothers in this age are often biologically ill-prepared for child-bearing[47]. A study of neonatal mortality by place of delivery in

Sao Paulo reported that, a significantly higher proportion of mothers of children not born in a hospital (health facility) were teenagers (<20 years) and had not completed primary education (eight years)[36]. Another study in Chile reported that, home deliveries presented a higher neonatal mortality and were more frequent in teenagers[36,48].

1.3.3. Maternal Socioeconomic Status

However, poverty is considered to be an underlying cause of many neonatal deaths, either through increasing the prevalence of risk factors such as maternal infection, or through reducing access to effective care[5]. Available evidence indicates that within each country, children from the poorest families are most likely to die and socio-economic inequalities impacted on child health and survival[49]. In addition, there is a synergistic interrelationship between poverty and increased neonatal mortality; neonatal mortality rates are 19% to 44% higher among the poorest families[50].Meanwhile, a study on the determinants of infant and child mortality in Tanzania found lack of differentiation in mortality by socioeconomic status[51]. But a study to update a systematic review on the association between childhood socioeconomic circumstances and cause-specific mortality confirmed that mortality risk for all causes was higher among those who experienced poorer socioeconomic circumstances during childhood[52]. Another study on child health inequity in rural Tanzania also revealed that at infancy, a child in a household categorised as poorest had about 50% higher risk of dying compared to one in a least poor household(test for trend p=0.05)[53]. Poor maternal socioeconomic status is therefore seen as a risk factor for neonatal mortality, especially in rural Tanzania.

1.4. Verbal Autopsy (VA)

Verbal autopsy is a procedure for gathering systematic information that enables a determination to be made of the cause of death in situations where the deceased has not been medically attended. It is based on the assumption that most common and important causes of death have distinct symptom complexes that can be recognized, remembered, and reported by lay respondents. It is a useful way to enhance the quality of mortality statistics in developing countries[2].

The purpose of VA is to describe the cause of mortality at the community or population level where no better alternative sources exist. It is, therefore, at best, a limited substitute for proper medical certification[54].

According to a study on the validity of verbal autopsy procedures for determining cause of death in Tanzania, verbal autopsy procedures are growing in importance as a source of data for populations lacking other reliable sources of mortality information. "Application and refinement of existing VA methods holds out the possibility of obtaining replicable, sustainable and internationally comparable mortality statistics of known quality for the majority of the world's population for whom such knowledge has, to date, been unavailable. Where its validity is known, VA has the potential to provide cost-effective information to guide policy, set priorities and track impact, particularly in countries undergoing rapid epidemiological and mortality transitions"[55]. However, verbal autopsy is an important method for deriving cause-specific mortality estimates where disease burdens are greatest and routine cause-specific mortality data do not exist."Verbal autopsies also reliably estimate Cause-Specific Mortality Fractions (CSMFs) for diseases of public health importance in all age groups in Tanzania"[55].

According to the validity of verbal autopsy procedures for determining cause of death study in Tanzania, verbal autopsy produced accurate Cause-Specific Mortality Fractions

(CSMFs) for nine causes in different age groups: birth asphyxia; intrauterine complications; pneumonia; HIV/AIDS; malaria (adults); tuberculosis; cerebrovascular diseases; injuries and direct maternal causes. Results for 20 other causes approached the threshold for good performance[55].

However, a study using data from sentinel vital registration (SVR) with verbal autopsy (VA) to determine the cause-specific mortality burden at the community level in two areas of the United Republic of Tanzania reported improved International Classification of Diseases tenth revision (ICD-10) coding practices. It also reported that, application of facility-based cause structures to counts of deaths from communities, derived from SVR, appears to produce reasonable estimates of the cause-specific mortality burden in those aged 5 years and older determined directly from verbal autopsy (VA).
And for the perinatal and neonatal age group, VA appears to be required[56].

1.5. Justification of Research

Place of delivery is an important aspect of reproductive health care. The place of delivery often determines the quality of care received by the mother and infant and is an important factor in differential risks of perinatal mortality[57]. Furthermore, reducing perinatal and neonatal mortality is a major thrust of current international public health policy[58]. So, by making available the epidemiological information regarding the time, place and causes of neonatal deaths, it is hoped that greater visibility will be given to neonatal deaths in policies and programme planning[59]. It has therefore become very important to investigate the association between neonatal mortality and place of delivery with a population based longitudinal dataset from a rural perspective.

1.6. Research Question

This study aims to contribute to the reduction of neonatal mortality and the achievement of the MGD on newborn survival by answering the research question: What is the effect of place of delivery on neonatal mortality in Rufiji in rural Tanzania?

1.7. General Objective

- ❖ To determine the effect of deliveries in health facilities and outside health facilities on neonatal mortality in Rufiji in rural Tanzania from 2005 to 2006.

1.8. Specific Objectives

1. To measure and compare the neonatal mortality rates among neonates born in and outside health facilities in Rufiji.
2. To compare the maternal characteristics of those who deliver in and outside health facilities in Rufiji.
3. To compare cause-specific neonatal mortality among neonates born in and outside health facilities in Rufiji.
4. To measure the association between place of delivery and neonatal mortality in Rufiji.

Chapter Two: Methodology

This chapter gives an insight into the Rufiji Demographic Surveillance system (RDSS), where this research was conducted. The chapter also gives a description of how this research was conducted and the data that was used to assess the relationship between neonatal mortality and place of delivery in the Rufiji district of Tanzania. The chapter contains; the study design, study population, study area, study sample and procedures of data collection. A brief description of the RDSS data management system and the data analysis techniques employed for this research is also presented in this chapter.

2.1. Study Design

This study was an analytical cross- sectional Study.The study was based on secondary data analysis of the Rufiji Demographic Surveillance System (RDSS) data on all neonatal mortality and live births that occurred from January 2005 to December 2006.

The place of delivery was classified into two groups: health facility and outside health facility. All deliveries that occurred in the homes and deliveries that occurred on the way to a health facility were all classified as outside health facility deliveries.

The deaths were also classified into two groups; health facility delivery deaths and outside health facility delivery deaths. The number of neonatal deaths was recorded.

Data on socioeconomic status of the study mothers using household assets as an index, sex of neonate, parity, maternal age at delivery, maternal occupation, maternal educational level and marital status were also extracted from the socio-economic status (SES) database, pregnancy database, membership database and mortality database.

Data on causes of death were collected using verbal autopsies. Cause specific mortality was determined by using physician coding according to a list of causes of death based on the 10^{th} revision of International Classification of Diseases. The VA data were extracted from the VA database by using a unique id which was the permanent id (perm_id) of the neonates.

2.2. Study Population

Rufiji district has a population size of about 226000 people. The population densities for the district and surveillance area are 12.5 and 46 per square km respectively. The mean household size for the whole district is about 5 persons. The DSS area comprises 31 villages with a population of approximately 93000 in about 18000 households. The RDSS area has an annual population growth rate of 2.3 and male to female sex ratio is 92.7:100.There are more females (52%) than males (48%) in the DSS area. The age dependency ratio is 110. The total fertility rate is 6.2 children per woman aged 15 to 49 years. In 2001, the infant mortality rate was 102/1000 live births, under five mortality ratio was 133/1000 live births while the under five mortality rate was 32.7/1000 under five person years and the average household size was 4.8 persons[60].

2.3 Study Area

This study was carried out at the Rufiji Demographic Surveillance System's Site (RDSS) in rural Tanzania. The RDSS is located in Rufiji District, which is about 178 kilometres south of the capital, Dar-es-Salaam (see appendix A). The district is largely rural though the population is clustered around Utete (district headquarters), Ikwiriri, Kibiti and Bungu townships.The Rufiji district has 56 health facilities. They include two hospitals (one government and one mission), five government health centres and 48 government dispensaries. A private dispensary based at Kibiti offers mobile clinic services in some parts of the district. About 89% of the population lives within 5 kilometres of a formal health facility. All villages and health facilities in the district have been positioned by GPS and mapped in a GIS database of district health resources. Rufiji Demographic Surveillance System (Rufiji DSS) is one of the continuous sources of rural, population-based data in coastal Tanzania[60] and it was established in 1998 as one of the major components of the Ministry of Health in Tanzania to operate the

Essential Health Interventions Project (TEHIP).The RDSS employed a non-randomised, purposive technique in selecting the areas under survey and are situated on the northern side of the Rufiji River basin. The Rufiji DSS (RDSS) area extends from 7.470 to 8.030 south latitude and 38.620 to 39.170 east longitude. The aim of the RDSS is to provide processed data about diseases affecting the target population in Rufiji district to the district health authorities and to the Ministry of Health headquarters in order to inform planners, priority setting and evidence- based decision- making and to monitor the impact of health interventions[60].

The RDSS approach involves a continuous monitoring of households and members within households in cycles or intervals, known as 'rounds' of four months each. Members (residents) of the RDSS are individuals who have resided in the survey area for a period of the previous four months. The RDSS collects information on demographic (including births, deaths and in-migration and out-migration), household, socio-economic and environmental characteristics of the population. Verbal autopsy is conducted on all RDSS registered deaths using specific standard questionnaires which are used to determine the probable cause of death (see appendix B). The verbal autopsy instruments and coding procedures used in the RDSS are identical to those used by the adult morbidity and mortality project, (AMMP)[60].

The characteristics of Rufiji DSS, as well as the availability of quality longitudinal data on neonatal mortality, cause of neonatal deaths and place of delivery makes Rufiji DSS a suitable place to carry out this study.

2.4. Study Sample

The sample for this study comprised of all children less than 29 days born between January 2005 and December 2006 to residents of the Rufiji DSA. Our sample also comprised of all deaths occurring to the same children during the same time period.

A total of 5124 live births and 166 deaths were registered during the study period.

A total of 113 neonatal deaths that occurred from January, 2005 to December, 2006, whose cause of death were identified through verbal autopsy procedures, by using physician coding according to a list of causes of death based on the 10th revision of International Classification of Diseases were used for the analysis of cause-specific neonatal mortality by place of delivery/births.

2.4. Data

The data for this analysis was obtained from the Rufiji Demographic Systems (RDSS), Tanzania. Data on the cause of death was based on the verbal autopsy data of the DSS site. In the RDSS, data is collected on births, deaths, in migration, out-migration, pregnancies, household, socio-economic and environmental characteristics of the population in the demographic surveillance area (DSA). A team of trained fieldworkers move from household to household to collect this information. A team of trained field supervisors also carry out quality control checks upon completion of interviews or household visits. The field supervisors randomly select and revisit between 3-5% of the households interviewed or updated by the enumerators for quality control. Each household in the surveillance area is visited four times in a year and on each visit, the demographic information of the household is updated. The data collection instrument used was structured and unstructured questionnaires (see appendices C and D) and trained fieldworkers who were fluent in the local language (Kiswahili) administered the questionnaires.

There is also a tracking team of fieldworkers who ensure that people moving within the DSA are reconciled with their records already captured into the database to avoid duplication of individuals moving within the study area[60].

2.5. Household Assets Data and Maternal Household Socio-Economic Status.

Household characteristics and assets ownership data was transferred from Microsoft visual fox pro professional edition version 5.0 database format into stata version 10 software with stat transfer. This information was used in the construction of household wealth index using Principal Component Analysis (PCA) in Stata version 10 software. The following variables were used for the PCA analysis; Hoe, matchet, bicycle, vehicle, motorbike, radio, refrigerator, television, clock, sofa, bed, video, mattress, wardrobe, pump, livestock, sewing machine, chicken, bednet, satellite dish, ceiling fan, iron, floor type, wall type, roof type and power or energy source.The assets were combined into a wealth index using weights derived through principal components analysis (PCA) using Stata version 10 software.

Construction of Wealth Index for Maternal Household Socio-Economic Status (SES) with the Principal Component Analysis, (PCA) Model.

PCA involves breaking down assets (e.g. radio, bicycle) or household service access (e.g. water, electricity) into categorical or interval variables. The variables are then processed in order to obtain weights and principal components. The results obtained from the first principal component (explaining the most variability) are usually used to develop an index based on the formula: $A_{j=}f_1 \text{ x } (a_{ji}\text{-}a_{i)}/(S_1) +\ldots\ldots\ldots+ f_N \text{ x}(aj_N - a_{N)}/(S_N)$.

Where f_1 is the scoring factor or weights for the first asset (or service), and a_1 and s_1 are the mean and the standard deviation of the first assets (or service) variable over all households respectively[1]. The Principal Component Analysis Model that was used to construct the wealth index (socio-economic indices) with household characteristics and ownership of assets was based on the model proposed by Filmer and Prichett in 2001[1].

This approach uses the PCA which involves a mathematical procedure that transforms a number of (possibly) correlated variables into a (smaller) number of uncorrelated variables[53]. In a study conducted in several states of India, Filmer and Pritchett found that the asset index produces comparable results with other measures. The author noted that the asset index significantly correlated with the state head count index as well as the domestic product per capita distributions[1].

According to Vyas and Kumaranayake, PCA is a multivariate statistical technique used to reduce the number of variables in a data set into a smaller number of 'dimensions'. In mathematical terms, from an initial set of n correlated variables, PCA creates uncorrelated indices or components, where each component is a linear weighted combination of the initial variables. For example, from a set of variables X_1through to Xn,

PC1 ¼ a11X1 þ a12X2 þ_ _ _þa1nXn

.
.
.

PCm ¼ am1X1 þ am2X2 þ_ _ _þamnXn

Where amn represents the weight for the mth principal component and the nth variable[61]. The model was based on the presence or absence of each asset or the nature of the housing materials .i.e. each asset was dummied with the response, 1 and 0. If the mother had the asset the response was 1, otherwise it was assigned 0. The generated wealth index was used to categorise the households of mothers of the neonates into five socio-economic groups or quintiles; poorest, poorer, poor, less poor, and least poor to arrived at maternal household socio-economic status.

2.6. Verbal Autopsy Data

Verbal Autopsy (VA) interviews on all DSS registered deaths are conducted by VA trained supervisors using specific standard questionnaires for:

a) Deaths of children under 29 days of age;

b) Those under 5 years but above 28 days; and

c) Deaths to those aged five years and above.

The interviews are held with one of the adult relatives of the deceased (preferably a caretaker) who was well informed of the sequence of events leading to death[60].

VA supervisors conduct interviews within two months of a death being reported and use any available documents such as death certificates and prescriptions to obtain confirmatory evidence about cause of death from the health facility where the deceased visited or was hospitalised for the last time. Such evidence, however, is often unavailable. The completed questionnaires are then coded independently by two physicians according to a list of causes of death based upon the tenth revision of the International Classification of Diseases. A third physician is used to independently code in the case of discordant results. Where there are three discordant codes, the cause is registered as unknown[60].

2.7. Data Management

Data management of the RDSS employs the standard Household Registration System (HRS) public domain computer software with in-built reporting and checking routines[62]. The HRS is capable of maintaining a consistent record of vital events that occur among a population in a fixed geographic area and generating up-to-date registration books for field use. Once enumerators have completed their interviews the data are taken to the RDSS data centre for entry. The data entered is then printed in loose sheets or forms known as household registration books (HRBs)[60]. The RDSS datasets were all in Microsoft visual FoxPro professional edition version 5.0 database. The verbal autopsy dataset, pregnancy dataset, membership dataset, social economic status dataset and the mortality dataset were all transfer from Microsoft visual FoxPro format with stat transfer to stata version 10. Data extraction, cleaning and merging for this study were done both in FoxPro and stata version 10.

Variables for this study were selected from the five different datasets mentioned above through an internal individual unique ID which is unique to all the live births and neonatal deaths in the database.

The extracted variables were:

1. **Outcome Variable**: The main outcome variable was neonatal mortality, defined as death occurring less than 28 days of birth and coded using verbal autopsy instrument or death certificate mortality information.
2. **Main explanatory variable:** The main explanatory variable was place of delivery which was defined as the place where a birth took place; either in a health facility or outside a health facility.
3. **Other explanatory variables:** The other explanatory variables used in the study were: maternal occupation, marital status, neonatal deaths, live births, parity, sex of neonates, neonatal age, maternal age at delivery, maternal educational and maternal household socio-economic status.

2.8. Data Analysis

The analysis was categorized into four parts. Firstly, after computing descriptive statistics, neonatal mortality rates by place of delivery (i.e. health facility delivery or outside health facility delivery) were calculated by dividing the total neonatal deaths that occurred in each place of delivery by the respective total live births that occurred in each place of delivery separately, multiplied by 1000. The total neonatal mortality rate was calculated by dividing the total neonatal deaths by the total live births multiplied by 1000.Secondly, we used a chi-square (x^2) test to compare the maternal characteristics of the mothers of the neonates who delivered in the health facility and those who delivered outside health facility. Thirdly, univariate and multivariate logistic regression methods were used to analyse the association between neonatal mortality and place of delivery

adjusted for potential confounders such as maternal age at delivery, maternal occupation, maternal education, social-economic status, parity and marital status).

Although some of the variables were not statistical significant in the univariate logistic regression models they were still included in the multivariate logistic regression models based on evidence from other literature. Lastly, the proportion of neonatal deaths by cause for each place of delivery was calculated.

2.9. Ethical Considerations

The original study had ethical clearance from the Ifakara Health Research and Development Centre's Institutional Review Board. This protocol has been approved by the University of the Witwatersrand's Committee for Research on Human Subjects (Medical) with protocol number M071142 in South Africa (see appendix E) and the Institutional Review Board of the Ifakara Health Research and Development Centre with ethical clearance number: IHRDC/IRB/No. A 021, in Tanzania (see appendix F). The study was neither invasive nor harmful. The datasets secure for the study were used for the purposes of this study only and it was handled with extreme care. The datasets were also anonymised.

The findings of this study were presented in the academic and scientific meetings of the University of the Witwatersrand's School of Public Health, Ifakara Research and Development Centre, Rufiji Demographic Surveillance System's Centre and Kintampo Health Research Centre.

Chapter Three: Results

This chapter presents the results of the analysis for this study. The analyses are in four parts. The first part of analysis consists of descriptive statistics and estimation of neonatal mortality by place of delivery (i.e. health facility delivery or outside health facility delivery) and by maternal characteristics. The second part of the analysis comprises the use of the chi-square (x^2) test to compare maternal characteristics of mothers who delivered in the health facility with those who delivered outside the health facility. The third part of the analysis involves the quantification of the proportion of cause-specific neonatal mortality by place of death.

The final part of the analysis involves the use of both univariate and multivariate logistic regression models to assess the association between neonatal mortality and risk factors such as place of delivery, maternal education, age and parity adjusted for potential confounders.

3.1 Socio-Demographic Profile.

From January 2005 to December, 2006, there were a total of 5124 live births and 166 neonatal deaths in the Rufiji Demographic Surveillance Area (Rufiji DSA). Out of the 5124 live births, 3442 (67%) occurred in health facility while 1682 (33%) occurred outside health facility. There were slightly more boys 2577 (50%) than girls 2547 (50%) born during the study period. There were no sex differentials in neonatal deaths 84 (51%) in females versus 82 (49%) in males. However, slightly more than half 85 (51%) of the neonatal deaths were of children born to women with primary education followed by those with no education 76 (46%) while 5 (3%) neonatal deaths were born to mothers with secondary education. Approximately one third 52 (31%) of the neonatal deaths occurred to children born to teenage mothers. Neonates of mothers older than 30 years of age experienced more deaths 59 (36%) compared to that of women who are in their twenties 55(33%).

The distribution of neonatal and maternal socio-demographic characteristics is presented in table one. The comparison of maternal characteristics by place of delivery is presented in table two. Table 3 shows the distribution of neonatal characteristics by place of delivery while table 4 presents the neonatal mortality rates by place of delivery. The association between neonatal mortality, place of delivery and maternal risk factors is presented in tables of five and six respectively.

However, figures one and two show the distribution of births and neonatal mortality by place of delivery and types of neonatal mortality by place of delivery and deaths.

Meanwhile, figures three, four and five show the distribution of causes of neonatal mortality by place of delivery.

3.2. Neonatal and Maternal Socio-demographic Characteristics

Table1: Distribution of Neonatal and Maternal Socio-demographic Characteristics in Rufiji DSS, 2005-2006, n= 5124.

Variables	Frequency	Percentage (%)
Maternal Education		
No Education	2222	43.4
Primary	2742	53.5
Secondary	160	3.1
Maternal Age		
<=19years (under 20s)	1045	20.4
20-29years	2224	43.4
30+years	1855	36.2
Maternal Marital Status		
Not Married	1127	22.1
Married	3424	66.8
Widowed/ Divorced/Separated	437	8.5
Other	136	2.6
Maternal Occupation		
Unemployed	298	5.8
Farming and Animal Husbandry.	3707	72.4
Clerical &Management, (White colour jobs).	850	16.6
Student	134	2.6
Other	135	2.6
Parity		
1-2	1058	20.6
3-4	2324	45.4
5+	1742	34.0
Maternal Household Socio-Economic Status (SES)		
Poorest	923	18.0
Poorer	1092	21.3
Poor	1134	22.1
Less poor	1084	21.2
Least poor	891	17.4
Livebirths		
Male	2577	50.2
Female	2547	49.8
Neonatal Age		
Under 8 days	46	1.0
8-28 days	4912	99.0
Neonatal Deaths		
Male	82	49.4
Female	84	50.6
Neonatal Age		
Under 8 days	111	66.9
8-28 days	55	33.1

Table1 shows the distribution of neonatal and maternal socio-demographic characteristics.

The table indicates that more than half (53%) of all the deliveries occurred amongst mothers with primary education compared to mothers with no education (43%) and those with secondary education (3%). Married women experienced more deliveries (67%) compared to the unmarried ones.

Women who were engage in farming activities had the highest deliveries (72%) compared to those who were engage in other occupations.

The total number of deliveries were fairly distributed across the various maternal household socio-economic quintiles. More than half (67%) of the neonatal deaths occurred in the first week of life.

3.3. Comparison of Maternal Characteristics by Place of Delivery

Table 2: Comparison of Maternal Characteristics by Place of Delivery

Maternal Characteristics	Deliveries in Health Facility n= 3442 (%)	Deliveries outside Health Facility n=1682 (%)	Total n = 5124	p-value
Parity				
1-2	842 (79.6)	216 (20.4)	1058	
3-4	1571 (67.6)	753 (32.40)	2324	< 0.001
5+	1029 (59.1)	713 (40.9)	1742	
Maternal Education				
No Education	1415 (63.7)	807 (36.3)	2222	
Primary	1889 (68.9)	853 (31.1)	2742	< 0.001
Secondary	138 (86.3)	22 (13.7)	160	
Maternal Age				
<=19years (under 20s)	790 (75.6)	255 (24.4)	1045	
20-29years	1496(67.3)	728 (32.7)	2224	< 0.001
30+years	1156(62.3)	699 (37.7)	1855	
Maternal Marital Status				
Not Married	815 (72.3)	312 (27.7)	1127	
Married	2222 (64.9)	1202(35.1)	3424	< 0.001
Widowed/ Divorced/Separated	306 (70.0)	131 (30.0)	437	
Other	99 (72.8)	37 (27.2)	136	
Maternal Occupation				
Unemployed	239 (80.2)	59 (19.8)	298	
Farming and Animal Husbandry.	2292(61.8)	1415 (38.2)	3707	
Clerical &Management, (White colour jobs).	706 (83.1)	144(16.9)	850	< 0.001
Student	102 (76.1)	32 (23.9)	134	
Other	103 (76.3)	32 (23.7)	135	
Maternal Household Socio-economic Status				
Poorest	473(51.3)	450 (48.7)	923	
Poorer	628(57.5)	464 (42.5)	1092	< 0.001
Poor	764(67.4)	370 (32.6)	1134	
Less poor	791(73.0)	293 (27.0)	1084	
Least poor	786(88.2)	105 (11.8)	891	
Total	**3442(67.2)**	**1682(32.8)**	**5124(100.0)**	

Table 2 shows the comparison of characteristics of mothers who delivered in health facility with those who delivered out-side health facility. The table indicates that in almost all the various maternal characteristics, there were more deliveries in a health facility compared to deliveries that occurred out-side a health facility.

Among mothers who had parity of one to two, 842 (80%) gave birth to their babies in a health facility while 216 (20%) gave birth to their babies outside a health facility but among mothers who had parity of five and above, 1029 (59%) gave birth to their babies in a health facility while 713 (41%) gave birth to their babies outside a health facility.

Furthermore, among mothers with no education 1415 (64%) gave birth to their babies in a health facility while 807 (36%) gave birth to their babies outside a health facility but among mothers with secondary education, 138(86%) gave birth in a health facility while 22(14%) gave birth to their babies outside a health facility.

Meanwhile, among the poorest mothers, 473(51%) gave birth in a health facility while 450 (49%) gave birth outside a health facility but among the least poor mothers, 786(88%) gave birth in a health facility while 105 (12%) gave birth outside a health facility.

3.4. Characteristics of Neonatal Deaths and Livebirths by Place of Delivery

Table 3: Distribution of characteristics of neonatal deaths and live births by place of delivery (n=5124)

Neonatal Characteristics	Deliveries in Health Facility n=**3442** (%)	Deliveries outside Health Facility n=**1682** (%)	Total n = **5124**	p-value
Age				
0-7days:(early neonatal deaths)	66 (59.5)	45 (40.5)	111	0.205
8-28 days:(late neonatal deaths)	27 (49.1)	28 (50.9)	55	
Age				
0-7(early neonates alive)	35 (76.1)	11 (23.9)	46	0.214
8-28(late neonates alive)	3314 (67.5)	1598 (32.5)	4912	
Sex(Dead)				
Male	43 (46.2)	39 (53.4)	82	0.358
Female	50 (53.8)	34 (46.6)	84	
Sex (Alive)				
Male	1714 (51.2)	781(48.5)	2495	
Female	1635 (48.8)	828 (51.5)	2463	0.082
Total	**3442(67.2)**	**1682(32.8)**	**5124 (100.0)**	

Results from Table 3 show that two thirds of neonatal deaths occurred in the first week of life. A total of 111 (67%) deaths occurred during the first week of life compared with 55 (33%) occurring more than one week of life, (p-value = 0.205). More than half 66(60%) early neonatal deaths occurred among children delivered in a health facility compared with 45 (41%) that occurred outside a health facility. Meanwhile, out of the 166 neonatal deaths, more deaths occurred in the group of children delivered in health facilities 93 (56%) compared with those delivered outside health facility 73 (44%),

(p-value = 0.002).

Meanwhile, chi-square test shows that, the overall comparison of neonatal characteristics such as age and sex by place of delivery were not statistical significant at 5% significance level.

3.5. Neonatal Mortality Rates (NMRs) by Place of Delivery

Table 4: Distribution of Neonatal Mortality Rates by Place of Delivery per 1000 live births

Place of Delivery	Deaths n=166 (%)	Livebirths n=4958 (%)	Total n=5124	NMR* (95% CI)	p-value
Health Facility	93(56.0)	3349(67.6)	3442	27.0 (21.7, 32.3)	**0.002**
OHF**	73(44.0)	1609(32.4)	1682	43.4 (42.0, 44.0)	
Total	**166**	**4958**	**5124**	**32.4 (27.2, 36.8)**	

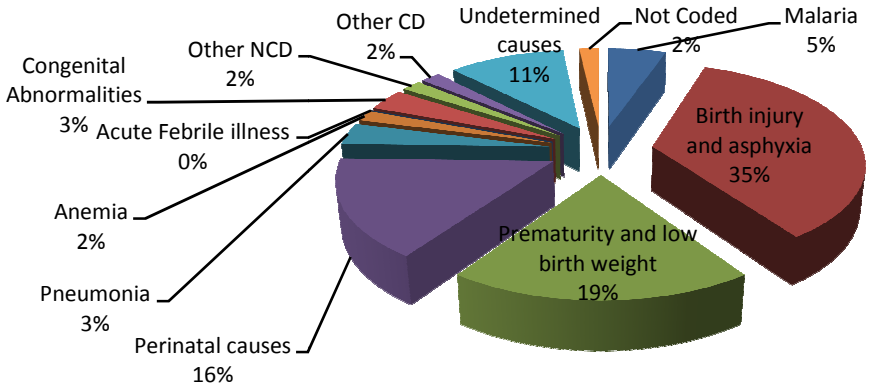
NMR*= Neonatal Mortality Rate per 1,000 live births
OHF= Out-Side Health Facility Deliveries/Births**

Table 4 shows that, neonatal mortality was higher in children born outside health facilities compared with those born in facilities, 43/1000 live births versus 27/1000 live births (p<0.002).

3.6. Cause-Specific Neonatal Mortality by Place of Delivery

The causes of neonatal mortality by place of delivery are presented in figures three, four and five.

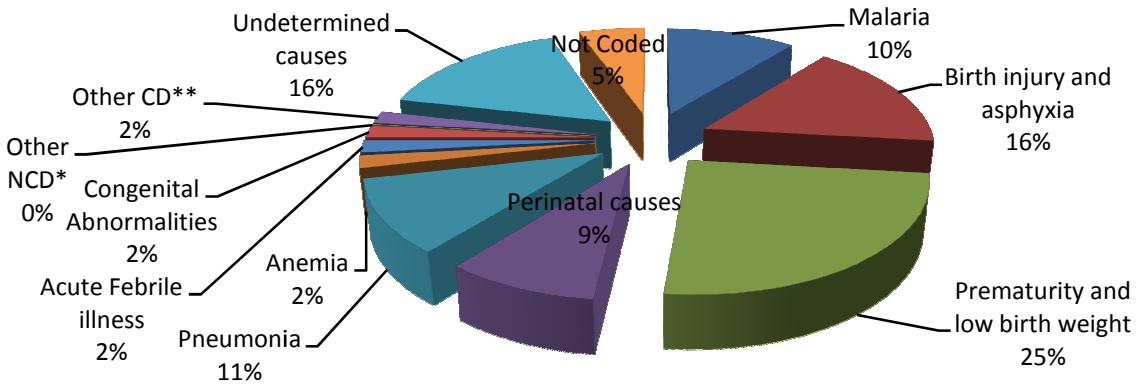
Out of 113 neonatal deaths with established cause of death, 57 (50%) were in health facility deliveries while 56 (50%) were in outside health facility deliveries.



*Other NCD=Other non-communicable diseases, Other CD= Other communicable diseases.

Figure 1: Causes of Neonatal Mortality in Health Facility Deliveries/Births

Figure 1 shows the distribution of causes of neonatal mortality in health facility deliveries. The major causes of neonatal mortality in health facility deliveries were birth injury and asphyxia (35%), prematurity and low birth weight (19%) and perinatal causes (16%).



Other NCD*=Other non-communicable disease, Other CD**= Other communicable disease.

Figure 2: Distribution of Causes of Neonatal Mortality in Out-Side Health Facility Deliveries/Births

Figure 2 shows the distribution of causes of neonatal mortality in outside health facility deliveries. The major causes of neonatal mortality in outside health facility deliveries were birth injury and asphyxia (16%), prematurity/low birth weight (25%), perinatal causes (9%), malaria (10%) and pneumonia (11%).

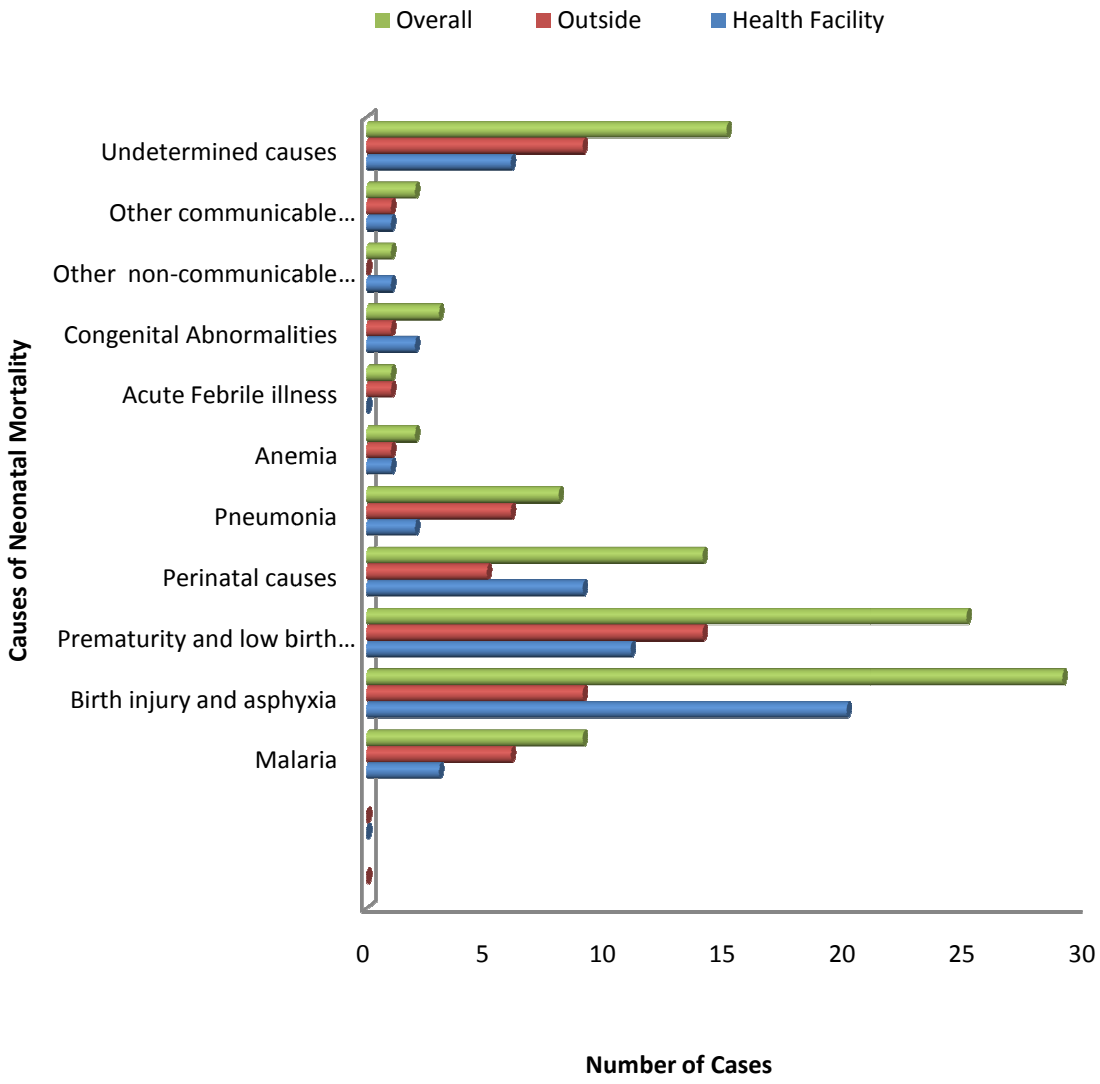


Figure 3: Distribution of Cause-Specific Neonatal Mortality by Place of Delivery

Figure 5 shows the distribution of causes of neonatal mortality by place of delivery. The major causes of neonatal mortality in both health facility and outside health facility deliveries were birth injury and asphyxia (n=29 cases), prematurity/low birth weight (n=25 cases), perinatal causes (n=14 cases), malaria (n=9 cases) and pneumonia (n=8 cases).

3.7. Maternal Risk Factors Associated With Neonatal Mortality

Table 6: Odds ratio (OR) estimates and 95% CI for maternal risk factors associated with Neonatal Mortality.

Univariate Analysis (unadjusted)			
Variable	**Odds Ratio**	**95% Confidence Interval**	**p-value**
Place of Delivery			
Health Facility*	1	-	-
Out-side Health Facility	1.6	1.2, 2.2	0.002
Parity			
1-2*	1	-	-
3-4	0.5	0.4, 0.8	0.001
5+	0.6	0.4 ,0.9	0.005
Education			
No education *	1	-	-
Primary	0.9	0.7, 1.2	0.53
Secondary	0.9	0.4, 2.3	0.84
Maternal Age			
under 20years*	1	-	-
20-29years	0.5	0.3, 0.7	<0.001
30+years	0.6	0.4, 0.9	0.016
Maternal Occupation			
Unemployed*	1	-	-
Farming and Animal Husbandry.	0.8	0.4, 1.5	0.52
Clerical &Management, (White colour jobs).	0.9	0.4, 1.8	0.75
Student	1.4	0.5, 3.8	0.46
Other	1.6	0.7, 4.2	0.30
Maternal Marital Status			
Not Married*	1	-	-
Married	0.8	0.6, 1.2	0.27
Widowed/ Divorced/Separated	1.0	0.6, 1.8	0.98
Other	1.4	0.6, 3.3	0.39
Maternal Socio-Economic Status			
Poorest*	1	-	-
Poorer	0.4	0.2, 0.6	<0.001
Poor	0.3	0.2, 0.5	<0.001
Less poor	0.4	0.3, 0.7	<0.001
Least poor	0.5	0.3, 0.8	0.003

***Comparison Group**

Table 6 indicates a univariate analysis of maternal risk factors associated with neonatal mortality.

The table shows that mothers who delivered outside a health facility were 1.6 times more likely to have experienced neonatal death [unadjusted OR=1.6, p-value = 0.002, 95% CI 1.2, 2.2] compared to mothers who delivered in a health facility.

Meanwhile mothers who had secondary education were 10% less likely to have experienced neonatal death [unadjusted OR = 0.9, p-value = 0.84, 95%CI 0.4, 2.3] compared to those who had no education.

Maternal age and parity were found to be significantly associated with neonatal mortality. Mothers who were aged 20-29 years and those aged 30 years and above were less likely to experience neonatal mortality compared to teenager mothers. Mothers aged 20-29 years were 50% less likely to have experienced neonatal death [unadjusted OR = 0.5, p-value = <0.001, 95% CI 0.3, 0.7] compared to mothers who were teenagers and this was statistically significant. Mothers who were also aged 30 years and above were 40% less likely to have experienced neonatal death [unadjusted OR= 0.6, p-value =0.016, 95% CI 0.4, 0.9] compared to teenage mothers.

Mothers who had parity of three to four were found to be 50% less likely to have experienced neonatal death compared with mothers who had parity of one to two. Meanwhile, mothers who had parity of five and above were found to be 40% less likely to have experienced neonatal death.

Maternal marital status and maternal occupation were not significantly associated with neonatal mortality. But maternal socio-economic status was significantly associated with neonatal mortality. Least poor mothers were 50% less likely to have experienced neonatal death [unadjusted OR = 0.5, p-value =0.003, 95%CI 0.3, 0.8] compared to the poorest mothers and this was statistically significant.

Table 7: Odds ratio (OR) estimates and 95% CI for maternal risk factors associated with Neonatal Mortality.

Multivariate Analysis (adjusted)			
Variable	**Odds Ratio**	**95% Confidence Interval**	**p-value**
Place of Delivery			
Health Facility*	1	-	-
Out-side Health Facility	1.7	1.2, 2.4	0.002
Parity			
1-2*	1	-	-
3-4	0.6	0.3, 0.9	0.033
5+	0.5	0.3,1.0	0.040
Education			
No education *	1	-	-
Primary	0.9	0.7,1.3	0.735
Secondary	0.9	0.4, 2.5	0.922
Maternal Age			
under 20years*	1	-	-
20-29years	0.7	0.4, 1.1	0.103
30+years	0.9	0.5,1.8	0.848
Maternal Occupation			
Unemployed*	1	-	-
Farming and Animal Husbandry.	0.9	0.5,1.9	0.840
Clerical &Management,	0.9	0.5, 2.0	0.930
(White colour jobs).			
Student	1.2	0.4,3.4	0.705
Other	1.4	0.5,3.7	0.509
Maternal Marital Status			
Not Married*	1	-	-
Married	1.2	0.7 ,1.8	0.517
Widowed/ Divorced/Separated	1.5	0.8 ,2.8	0.234
Other	0.8	0.3 ,2.0	0.677
Maternal Socio-Economic Status			
Poorest*	1	-	-
Poorer	0.4	0.2, 0.6	< 0.001
Poor	0.3	0.2 ,0.6	< 0.001
Less poor	0.5	0.3, 0.8	0.002
Least poor	0.6	0.4, 1.1	0.046

***Comparison Group**

Table 7 presents a multivariate analysis of maternal risk factors associated with neonatal mortality. The table shows that after adjusting for maternal risk factors, mothers who delivered out-side health facility were 1.7 times more likely to had experience neonatal mortality [adjusted OR=1.7, p-value = 0.002, 95%CI 1.2, 2.4] compared to mothers who delivered in health facility and this was statistically significant.

Maternal age, maternal education, maternal marital status and maternal occupation were all not statistically significant in the multivariate analysis.

However, parity and maternal socio-economic status were the only other factors that were found to be statistically significant in the multivariate analysis. For instance, least poor mothers were found to be 40% less likely to have experienced neonatal mortality [adjusted OR = 0.6, p-value = 0.046, 95% CI 0.4, 1.1] compared to the poorest mothers and this was statistically significant. Less poor mothers were also found to be 50% less likely to experience neonatal mortality [adjusted OR =0.5, p-value = 0.002, 95% CI 0.3, 0.8] compared to the poorest mothers.

Mothers who had parity of 3-4 were found to be 40% less likely to have experienced neonatal death compared to mothers who had parity of one to two. Mothers who had parity of five and above were also found to be 50% less likely to have experienced neonatal death compared to those who had parity of one to two.

Chapter Four: Discussion

Millennium Development Goals (MDGs) and the World Health Report 2005 are putting special attention to maternal and child health[63], because almost 40% of deaths in children aged under 5 years of age occur in the neonatal period and this proportion is increasing as the numbers of post-neonatal deaths fall more rapidly[64].Yet neonatal deaths receive limited attention[65]. Therefore interventions to address neonatal mortality are crucial if child mortality is to be reduced globally, and in Tanzania, in order to attain the MDGs. Meanwhile, the choice of place of delivery has consistently been found to be associated with maternal and neonatal outcomes[66,67,68]. Childbirth in a medical institution attended to by trained medical staff has been shown to be associated with lower rates of maternal and neonatal mortality and morbidity than home births[69,70,71].However, most of these studies are based on health facility data which does not show the true magnitude of the situation at hand. The aim of this study was therefore to investigate the relationship between neonatal mortality and place of delivery with longitudinal population based data from a rural perspective.

The results of this study as presented in the preceding chapter addresses four issues.

Firstly, it provides information on neonatal mortality rates by place of delivery and percentage of neonatal deaths in health facility and outside health facility by maternal and neonatal characteristics. Secondly, it provides information on the characteristics of the mothers who deliver their newborns in health facility and those who deliver their newborns outside the health facility. Thirdly, the results of study give information on the specific causes of neonatal deaths in health facility deliveries, outside health facility deliveries and in both places of delivery. Lastly, the results of the study also show the relationship that exists between place of delivery and neonatal mortality. The results of the study shows that delivery outside a health facility is more likely to lead to neonatal or newborn death as compared to delivery in a health facility and thus, highlighting the

crucial role of place of delivery on newborn survival and the impact that place of delivery has on neonatal mortality.

4.1. Neonatal Mortality Rates (NMRs) By Place of Delivery.

Results from this study have shown that neonatal mortality rate in children born outside health facilities is 43/1000 live births (95% CI 42.0, 44.0) compared to 27/1000 live births (95% CI 21.7, 32.3). The results show that the overall mortality in Rufiji district is 32/1000 live births. This results is similar to the in the 2004-05 Tanzania Demography and Health Survey (TDHS) which reported neonatal mortality rate of 32/1000 live births[11]. This finding is also consistent with the average neonatal mortality rate of 33/1000 live births for middle-income and low-income countries where 99% of neonatal deaths occurs[5]. The overall neonatal mortality rate is also consistent with neonatal mortality rates in other Sub Saharan countries: Uganda (32/1000 live births), Burkina Faso (31/1000 live births) and Madagascar (32/1000 live births)[72].

Significant differentials were found in neonatal mortality rates by place of delivery. The neonatal mortality rate of 43/1000 live births in the deliveries that occurred outside health facility is consistent with the neonatal mortality rate in 1905 in England which was 41/1000 live births the average for sub-Saharan Africa today[73]. The current TDHS 2004-5 overall neonatal mortality of 32/1000 live births for children delivered in health facilities indicates a great improvement in neonatal survival in rural Tanzania but there is still more room for further improvement.

The findings of this study are also in line with the Save the Children's Opportunities for Africa's Newborns report which states that, a neonatal mortality rate of 30-44/1000 live births is made of 48% mixture of home and health facility newborns while a neonatal morality rate of 15-29/1000 live births has majority (65%) health facility newborns[72]. According to the report, a neonatal mortality rate of less than 15/1000 live births has

almost exclusively (98%) health facility newborns[72]. A delivery outside health facility is significantly associated with higher neonatal mortality in rural Tanzania.

4.2.Maternal Characteristics by Place of Delivery.

In sub-Saharan Africa, 18 million women give birth at home; in fact, in many African countries, the majority of women still give birth at home, assisted only by family members, if not alone. Within countries, too, there are great disparities in the use of skilled care while 25% of the highest income quintile in Ethiopia use a skilled provider, only 1%t of the poorest women do[74].

The findings of the study indicate that the differences in parity of mothers who delivered in health facility and those who delivered outside health facility is statistically significant (p–value=<0.001). However, among mothers who are of parity of zero to one, a quarter 842(25%) delivered in health facility compare to 216(13%) of mothers who delivered outside health facility. Among mothers who are of parity of five and above, the majority of them delivered outside health facility and this is consistent with a study of place of delivery among women who had antenatal care in a teaching hospital in Sokoto, Nigeria which found that there were more women of high parity with previous home birth in the home delivery group (p-value=<0.05)[75].The findings also concurs with a study of factors affecting place of delivery in Kathmandu valley in Nepal which found that multi-parity increase the risk of home delivery in Kathmandu [adjusted OR =3.1, p-value = 0.001, 95% CI (1.6, 5.7)] compared to primiparity mothers[76].

The findings of the study shows that, the difference in educational status of mothers who delivered in health facility and those who delivered outside health facility are statistically significant (p-value=<0.001).

Almost half of mothers with no education (48%) delivered outside a health facility while more than half of the mothers with primary education (55%) delivered in a health facility. Most of the women with secondary education also delivered in health facility. This finding concurs with a Nigerian study which found that there were more literate women amongst the hospital delivery group[75]. The findings also support the findings of an Indian study which found very high (94%) home deliveries among uneducated Utter Pradesh women[77]. The findings of this study is also consistent with a study of maternal health care utilisation in Teso district in Kenya which found that more educated women are more likely to deliver in a health facility[78]. The findings are also consistent with another study in Nepal which found that low maternal educational level [adjusted OR =5.0, 95% CI (1.6, 15.8) for no education, adjusted OR=3.4, 95%CI (1.0-10.8) for class 1-10] is significant risk factor for home delivery compared to those with higher education[76].The findings of this study indicate that the difference in the maternal age of those who delivered in health facility and those who delivered outside health facility is significant (p-value=<0.001).

However, the proportion of outside health facility deliveries is higher in mothers who are 30 years and above (38%) compared to teenagers (24%). But there is no significant difference among mothers who are 20-29 years with respect to place of delivery. This finding concurs with a study in Kenya which found that young women are more likely to deliver in a health facility[78]. The findings are also within the findings of another study in Kenya which was looking for explanations to an upsurge in early childhood mortality in Kenya[79]. The Kenyan study shows that in 1989, 57% of teenage mothers delivered in health facility as against 51% for those who were aged 20-34 years and 40% for those who were 35 years and above[79]. This trend continued in 1993 with 50% of teenage mothers delivering in health facility as against 47% for those aged 20-34

years and 33% for those who were 35 years and above[79]. However in 1998, more women (44%) who delivered in a health facility were of ages 20-34 years but this was closely followed by teenage mothers (43%) while the trend of lower delivery in health facility (29%) in older women (35+years) continued[79]. The findings of this study is also consistent with a study in Ethiopia which reported that even though a larger proportion (70-80%) of both older mothers and teenage mothers gave birth at home, the odds were twice as high for teenage mothers (95% CI = 1.55, 2.64)[80]. However, it was in contrast to findings of studies in Kenya and Uganda which reported that half of the teenage and about 70% of the adult mothers in Kenya gave birth in health facilities (OR=0.47; 95% CI 0.34, 0.65) but similar proportions of both groups of Ugandan mothers also gave birth in health facilities (OR= 0.69; 95% CI 0.49, 0.97)[80]. The differences in marital status, occupation and socioeconomic status of mothers who delivered in health facility and those who delivered outside health facility are all significant (p-value=<0.001) at 5% significance level. Deliveries outside a health facility increase with increasing age and increasing levels of poverty. With respect to farming, the finding is that of all occupational types, farming had the highest proportion of outside deliveries.

The findings of this study are consistent with findings of a study of factors affecting place of delivery in rural Tanzania which reported that mothers with primary and higher education were more likely to deliver at a health facility (RR 1.30, 95% CI 1.23–1.38).Younger mothers and the least poor women were also more likely to deliver in a health facility compared with the older and the poorest women, respectively[81]. Maternal characteristics are key determinants of choice of place of delivery in rural Tanzania.

4.3 Cause-Specific Neonatal Mortality by Place of Delivery.

Asphyxia claims many babies during the first day, and the majority of deaths due to preterm birth occur during the first week. Thirty-eight percent of babies in sub-Saharan Africa die of infections, mainly after the first week of life[72]. Babies born in sub-Saharan Africa have a very high risk of birth asphyxia and of intrapartum stillbirth[82]. The single most common killer of newborns is neonatal infection, particularly sepsis (blood infection), pneumonia, and meningitis (infection of the lining of the brain)[72].

The findings of this study indicates that, the two major causes of deaths in both health facility deliveries and outside health facility deliveries are birth injury and asphyxia 29(26%) and prematurity/low birth weight 25(22%). But usually health facility data will show a very high percentage of deaths due to asphyxia since complicated births are more likely to come to health facility[72]. Furthermore, early neonatal deaths account for 75% of all neonatal deaths which are caused by birth asphyxia and prematurity which are causes of death that are unique to the first week of life[5]. The majority of the deaths in this study were early neonatal and this could explain why birth asphyxia and prematurity are the major causes of death in this study. However, this finding is within the reported main causes of neonatal deaths which are; infections, prematurity, birth asphyxia and congenital malformations[5]. This study also reflects the major causes of neonatal mortality in Tanzania which are; preterm (27%), infection (28%) and asphyxia (26%)[72]. The findings also conform to global estimates of direct causes of neonatal mortality which are estimated to be preterm birth (28%), severe infections (26%), and asphyxia (23%)[5]. The findings of this study are also consistent with that of a study at the Navrongo Health and Demographic System's Site in Ghana which reported prematurity, 38%, and birth injuries, 19%, as the leading causes of death in the early neonatal period[38].

These findings also concur with a study in Tanzania that reported birth asphyxia of 37% and prematurity of 29% as the common causes of neonatal mortality[83].

4.4 Effect of Place of Delivery on Neonatal Mortality.

According to Save the Children's Opportunities for Africa's Newborn report, sub-Saharan Africa has the highest rates of neonatal mortality in the world and has shown the slowest progress in reducing newborn deaths, especially deaths in the first week of life. Each year, at least 1.16 million African babies die in the first 28 days of life – and 850,000 of these babies do not live past the week they are born[72]. The findings of this study indicate that delivery out side a health facility is a risk factor of neonatal mortality. This finding concurs with the 2005 World Health Report which states that, giving birth in a health facility (not necessary a hospital) with professional staff is safer by far than doing so at home[84]. The findings also conform to findings from Demographic and Health Survey (DHS) data from 40 countries collected between 1995 and 2003 which reported that more than 50% of neonatal deaths occur after home birth without skilled care attendance[5]. The findings are also consistent with a study in rural Tanzania that documented that home births without a trained attendant resulted in a three times higher perinatal mortality than those in a health facility with trained attendants in rural Tanzania[32].

These findings are also in line with those of a study in Papua New Guinea which reported high rate of obstetric complications among apparently normal pregnancies delivering at home in Papua New Guinea[33].

4.5 Implications of Findings

The findings of this study have a lot of implications for all stakeholders in the fight against neonatal mortality in sub-Saharan Africa in general and Tanzania in particular.

Firstly, there was no difference in the causes of neonatal mortality in deliveries that occurred in a health facility and those that occurred outside health facility. This is quite worrying and an indication of a weak health system with lack of appropriate expertise.

There is therefore an urgent need to find out why causes of neonatal mortality in health facility deliveries and outside health facility deliveries were very similar and adopt appropriate strategies to combat them since such issues could be a disincentive to pregnant women to deliver in a health facility.

This could further affect the fight against neonatal mortality negatively, thereby jeopardising efforts made in attaining the fourth Millennium Development Goal.

Secondly, deliveries that occurred outside health facility had the highest neonatal mortality rate which was almost double the neonatal mortality rate that occurred in health facility. This is therefore strong evidence, based on longitudinal population data that could inform policy makers to do everything to reduce outside health facility deliveries. However, there is the need for the analysis of longitudinal dimension of the data to examine trends over time. This could provide additional information to policy makers. Meanwhile interventions aimed at reducing neonatal mortality must incorporate programmes such as micro-financing that would improve the socio-economic status of pregnant women since it is strongly associated with neonatal mortality. The findings of this study could also be use as a guide for policy makers in designing interventions aimed at reducing neonatal morality in Tanzania.

Lastly, the findings indicate that women who give birth outside a health facility are 1.7 times more likely to experience neonatal mortality compare to women who give birth in

health facility. This lends more credence to the vital role place of delivery plays in neonatal survival. It can therefore be said without any ambiguity that, if greater efforts are made to increase health facility delivery and reduce outside health facility by all stakeholders, neonatal mortality could be reduce significantly in Tanzania.

The way forward in achieving the national strategy for growth and reduction of poverty (NSGRP) of the United Republic of Tanzania which aims to reduced infant mortality from 95 in 2002 to 50 in 2010 per 1,000 live births among other things and the MDG-4, is to strengthen the health system and reduce outside health facility delivery while increasing health facility deliveries.

4.6 Limitations of Study

The results of this study should be interpreted cautiously, bearing in mind the following limitations: Information on who assisted during delivery was not collected, instead we used health facility as a proxy for delivery by trained health personnel. This might not be the case in most health facilities in this rural area because of the shortage of such staff. The second limitation in this study is the use of verbal autopsy in ascertaining causes of deaths. VAs as good as they are, still suffer misclassification errors and a large number of undetermined causes[54,55,56]. This could affect the results of the study.

The third limitation is missing deaths, i.e. under-reporting especially in the perinatal period. If a birth and a death occur between census update rounds, there is the possibility that these events will be missed. The last limitation of this study is the lack of data on birth weight, HIV/AIDS status of mothers and religion in the 2005-2006 RDSS datasets. This study was therefore unable to assess the association of these variables with neonatal mortality.

Chapter Five: Conclusions and Recommendations

There were a high number of neonatal deaths that occurred in the first week of life. Therefore interventional measures should target this period in order to make a very significant impact in the reduction of neonatal mortality.

Place of delivery or birth has a very significant impact on neonatal survival. Therefore in order to reduce neonatal mortality in rural Tanzania, non-governmental organizations, government and all other stakeholders should work harmoniously to develop and implement programmes that would educate, encourage and supported pregnant women to deliver or give birth to their newborns in a health facility while discouraging births or deliveries that occurred outside health facility.

There is the need for qualitative research to explore the barriers or issues militating against health facility delivery and inform policy.

The major maternal risk factor for neonatal mortality was maternal household socio-economic status. There is therefore the urgent need for all stakeholders, non-governmental organizations and government of Tanzania to formulate and implement policies and programmes that will improve and make the socio-economic status of mothers and pregnant women in rural Tanzania better in order to reduce neonatal mortality.

The major causes of deaths in both health facility deliveries and outside health facility deliveries were birth injury and asphyxia and prematurity and low birth weight.

Interventions aimed at preventing causes of neonatal mortality in rural Tanzania should therefore first and foremost concentrate on reducing birth injury and asphyxia and prematurity and low birth weight in order to make a greater impact in the reduction of neonatal mortality in rural Tanzania.

This study highlights the crucial roles of maternal household socio-economic status, parity and place of delivery as very important risk factors of neonatal mortality in rural Tanzania.

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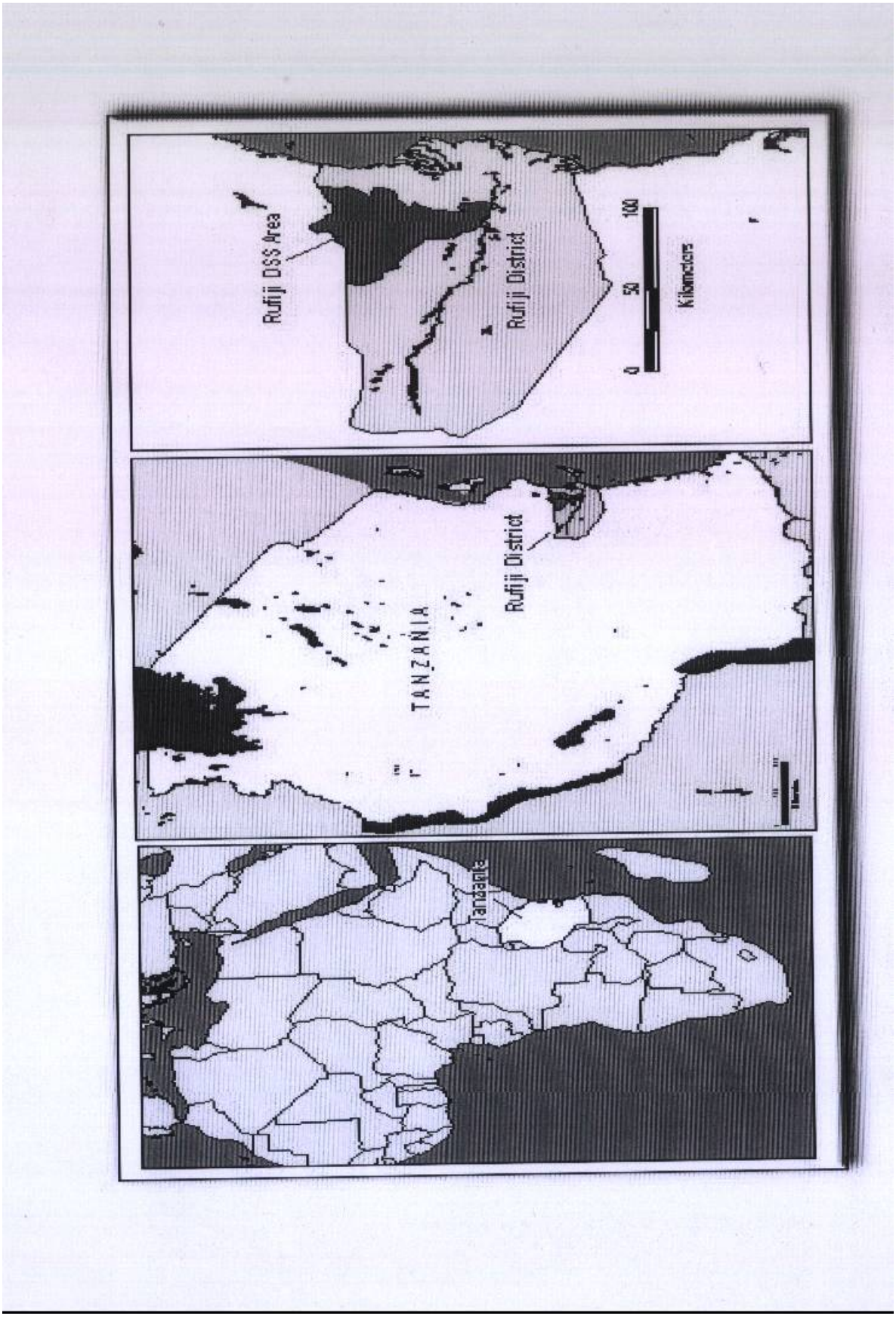
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Appendix-A


Rufiji DSS Area
Rufiji District
0
50
100
Kilometers
TANZANIA
Rufiji District
Tanzania

Appendix-B

NSS VA Form VA2002-1

VERBAL DIAGNOSIS FORM: DEATH OF CHILDREN UNDER 29 DAYS

Area	Serial Number		
Date of interview			
Interviewer			
Village/Branch			
Name of ten cell leader			
Name of head of household			
Relationship of respondent to the deceased	1-Father 2-Mother 3-Spouse 4-Sibling 5-Child 6-Other relative 7-No relation		
Did you live with the respondent in the period leading to death?	1-Yes 2-No		
Name of deceased			
Sex 1-Male 2-Female	Day	Month	Year
Place of death	N-Home H-HEalth facility O-Other		
Date of death	Day	Month	Year

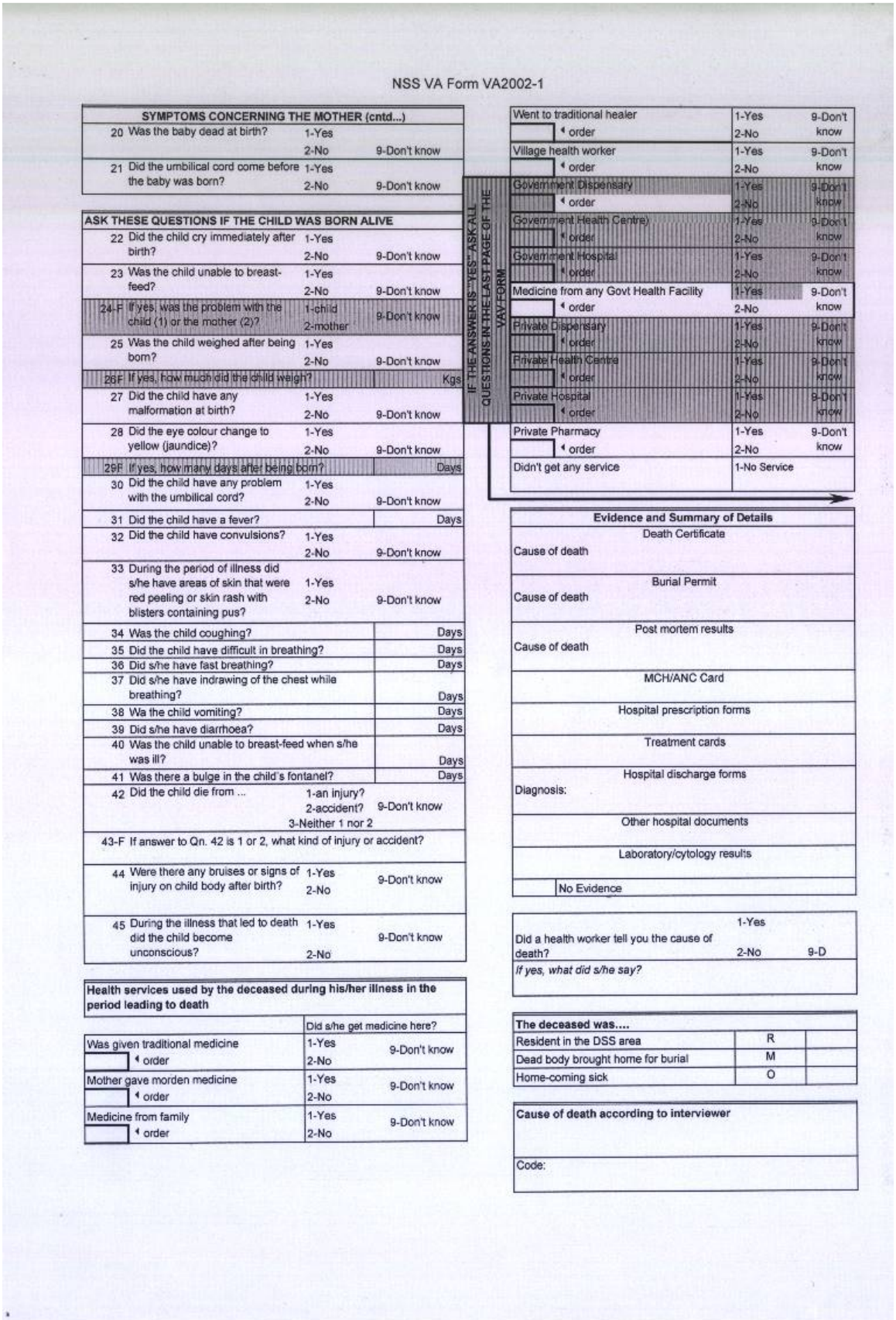
What do you think was the cause of death? (Write exactly as the respondent tells you)
History of events leading to death

"Excuse me, I will ask you some questions concerning symptoms that the deceased had/showed when s/he was ill. Some of these questions may not appear to be directly related to his/her death. Please bear with me and answer all the questions. They will help us to get clear picture of all possible symptoms that the deceased had"

SYMPTOMS CONCERNING THE MOTHER		
1 How is the child's mother now?	1-healthy, fine 2-she is sick 3-died	9-Don't know
2 Was it a difficult birth?	1-Yes 2-No	9-Don't know
3 Did the mother have fits before giving birth?	1-Yes 2-No	9-Don't know
4 Did/does the mother have high blood pressure?	1-Yes 2-No 9-Don't know	
5 Did the mother have a febrile illness at the time of delivery?	1-Yes 2-No	9-Don't know
6 Did thechild's mother suffer from any of these conditions?	1-Diabetes 2-Heart disease 3-TB 4-Epilepsy 5-None	9-Don't know

EVENTS DURING BIRTH OF A CHILD		
7 Where did the mother give birth?	1-Home 2-Health facility 3-In transit 4-Other place	9-Don't know
8 Who assisted the birth?	1-none 2-Untrained TBA 3-Trained TBA 4-Health professional	9-Don't know
9 Had the mother received Tetanus Toxoid vaccination (TT)?	1-Yes 2-No	9-Don't know
10 If yes, how many TT injections did she receive?	(number)	
11 Was the child ...	1-a singleton? 2-twin	9-Don't know
12 Was it a forceps or vacuum delivery?	1-Yes 2-No	9-Don't know
13 Was it a caesarian delivery?	1-Yes 2-No	9-Don't know
14 Was it a prolonged labour?	1-Yes 2-No	9-Don't know
15 Did waters break 1 day or more before contractions during late pregnancy, labour or delivery?	1-Yes 2-No 9-Don't know	
16 Was the child premature?	1-Yes 2-No	9-Don't know
17F If yes, how many months or weeks?		Months Weeks
18 Did the baby stop 'playing' in the womb before labour?	1-Yes 2-No 9-Don't know	
19 If no, did the baby breathe at all after delivery?	1-Yes 2-No	9-Don't know

Appendix-B (Continuation)



NSS VA Form VA2002-1

SYMPTOMS CONCERNING THE MOTHER (cntd...)		
20 Was the baby dead at birth?	1-Yes 2-No	9-Don't know
21 Did the umbilical cord come before the baby was born?	1-Yes 2-No	9-Don't know

ASK THESE QUESTIONS IF THE CHILD WAS BORN ALIVE		
22 Did the child cry immediately after birth?	1-Yes 2-No	9-Don't know
23 Was the child unable to breast-feed?	1-Yes 2-No	9-Don't know
24-F If yes, was the problem with the child (1) or the mother (2)?	1-child 2-mother	9-Don't know
25 Was the child weighed after being born?	1-Yes 2-No	9-Don't know
26F If yes, how much did the child weigh?		Kgs
27 Did the child have any malformation at birth?	1-Yes 2-No	9-Don't know
28 Did the eye colour change to yellow (jaundice)?	1-Yes 2-No	9-Don't know
29F If yes, how many days after being born?		Days
30 Did the child have any problem with the umbilical cord?	1-Yes 2-No	9-Don't know
31 Did the child have a fever?		Days
32 Did the child have convulsions?	1-Yes 2-No	9-Don't know
33 During the period of illness did s/he have areas of skin that were red peeling or skin rash with blisters containing pus?	1-Yes 2-No	9-Don't know
34 Was the child coughing?		Days
35 Did the child have difficult in breathing?		Days
36 Did s/he have fast breathing?		Days
37 Did s/he have indrawing of the chest while breathing?		Days
38 Wa the child vomiting?		Days
39 Did s/he have diarrhoea?		Days
40 Was the child unable to breast-feed when s/he was ill?		Days
41 Was there a bulge in the child's fontanel?		Days
42 Did the child die from ...	1-an injury? 2-accident? 3-Neither 1 nor 2	9-Don't know
43-F If answer to Qn. 42 is 1 or 2, what kind of injury or accident?		
44 Were there any bruises or signs of injury on child body after birth?	1-Yes 2-No	9-Don't know
45 During the illness that led to death did the child become unconscious?	1-Yes 2-No	9-Don't know

Health services used by the deceased during his/her illness in the period leading to death		
	Did s/he get medicine here?	
Was given traditional medicine ◂ order	1-Yes 2-No	9-Don't know
Mother gave morden medicine ◂ order	1-Yes 2-No	9-Don't know
Medicine from family ◂ order	1-Yes 2-No	9-Don't know

IF THE ANSWER IS "YES" ASK ALL QUESTIONS IN THE LAST PAGE OF THE VAV FORM

Went to traditional healer ◂ order	1-Yes 2-No	9-Don't know
Village health worker ◂ order	1-Yes 2-No	9-Don't know
Government Dispensary ◂ order	1-Yes 2-No	9-Don't know
Government Health Centre) ◂ order	1-Yes 2-No	9-Don't know
Government Hospital ◂ order	1-Yes 2-No	9-Don't know
Medicine from any Govt Health Facility ◂ order	1-Yes 2-No	9-Don't know
Private Dispensary ◂ order	1-Yes 2-No	9-Don't know
Private Health Centre ◂ order	1-Yes 2-No	9-Don't know
Private Hospital ◂ order	1-Yes 2-No	9-Don't know
Private Pharmacy ◂ order	1-Yes 2-No	9-Don't know
Didn't get any service	1-No Service	

Evidence and Summary of Details
Death Certificate Cause of death
Burial Permit Cause of death
Post mortem results Cause of death
MCH/ANC Card
Hospital prescription forms
Treatment cards
Hospital discharge forms Diagnosis:
Other hospital documents
Laboratory/cytology results
☐ No Evidence

Did a health worker tell you the cause of death?	1-Yes 2-No	9-D
If yes, what did s/he say?		

The deceased was....		
Resident in the DSS area	R	
Dead body brought home for burial	M	
Home-coming sick	O	

Cause of death according to interviewer
Code:

Appendix-C

Rufiji Demographic Surveillance System (RDSS)
Socio Economic Indicators

Interviewer ☐☐
Date of Interview ☐☐/☐☐/☐☐
Village ☐☐☐ **Household Number** ☐☐☐☐

1. Does anyone in this household own any of the following items?

(Write in the box1if answer is yes or 2 if answer is no)

1. Bicycle	☐	2. Car	☐	3. Motocycle	☐
4. Radio	☐	5.Refrigerator or freezer	☐	6. Television (TV)	☐
7. Watch	☐	8.Own land	☐	9.Sofa	☐
10. Bed	☐	11.Electric Iron.	☐	12.Video	☐
13. Mattress	☐	14.Wardrobe	☐	15. Water pump	☐
16. Cattle	☐	17. Sewing Machine	☐	18.Poultry	☐
19. Mosquito net	☐	20. Satellite dish	☐	21.Ceiling fan	☐
				22. Mobile phone	☐

2. Is the house owner a member of household? *(write 1 if answer is yes and 2 if answer is no)* ☐

1. Yes 2. No

(NB from question 3 to 9 write in the box the correct answer)

3. What are the floors of this house made of? ☐

1. Earth / Mud 2.Wood
3. Tiles 4. Cement
5. Other .....

4. What are the walls of this house made of? ☐

1. Stone, Coral Block, Cement block, Burnt bricks
2. Mud bricks (plastered or unplastered), Wood
3. Galvanised, mud & stick, mud
4. Grass, card board
5. Other .....

5. What is the roof of the house made of? ☐

1.Tiles, concrete, cement
2. Galvanised iron or asbestos
3. Bamboo, wood, mud, grass ,thatch, plastic or papers, tins
4. Others .....

6. How many rooms are used for sleeping in this household? .....

7. What is the main source of energy for cooking in this household? ☐

1. Electricity, gas, solar 2. Firewood
3. Kerosene fuel, Biogas, charcoal
4. Crop residue, coconut husks, sawdust, grass, chaff, animal dung
5. Other.....

Appendix-C (Continuation)

8. What is the main source of water for this household (general use of water)
   1. Piped into residence
   2. Private well in the house
   3. Public wells and pipes
   4. Vendor
   5. River, canal, spring, dam
   6. Other .....

9. What is the main toilet facility for this household?
   1. Private flush
   2. Shared flush
   3. Vip or pit
   4. Normal pit latrine
   5. Neighbourhood or bush
   6. Other.....

Checked by

Appendix-D

Rufiji Demographic Surveillance System (DSS)
Pregnancy Outcome / Birth Form

Enumerator's initials ⌊__⌋

Pregnancy Outcome ⌊__⌋ Date of Event ⌊__⌋/⌊__⌋/⌊__⌋

(**ABT**=Abortion; **MIS**=Miscarriage; **STB**=Stillbirth; **BIR**=Birth; **DMO** =Mother died with baby)

Where did the event occur (**N**=Home, **H**=Hospital, **O**=Other Places) ⌊_⌋

Who assisted you during delivery? (**1**=Nobody, **2**=Untrained TBA, **3**=Trained TBA

4=Health Professional/Nurse/Midwife **5**=Don't know) ⌊_⌋

Event reported in round ⌊__⌋

Details of Mother:

Village ⌊__⌋

Hamlet ⌊__⌋

Family number ⌊__⌋

Member number ⌊__⌋

Name ⌊__⌋

Details about the Delivery

Number of live birth ⌊__⌋

Details about the Child
Are they twins? 1-Yes 2- No ⌊_⌋

Village ⌊__⌋ Name ⌊__⌋

Family number ⌊__⌋ Sex (Male=M, Female=F) ⌊_⌋

Member number ⌊__⌋ Relation to household head ⌊__⌋⌊_⌋

Father ID ⌊_⌋⌊_⌋⌊_⌋⌊_⌋⌊_⌋⌊_⌋⌊_⌋⌊_⌋⌊_⌋⌊_⌋⌊_⌋

Checked By ⌊__⌋

Appendix-E

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Ajaari

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER M071142**
PROJECT	Does Place of Delivery Affect Neonatal Mortality in Rufiji in Rural Tanzania?
INVESTIGATORS	Mr J Ajaari
DEPARTMENT	School of Public Health
DATE CONSIDERED	07.11.30
DECISION OF THE COMMITTEE*	APPROVED UNCONDITIONALLY

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 07.12.07 **CHAIRPERSON** .....
(Professors PE Cleaton-Jones, A Dhai, M Vorster, C Feldman, A Woodiwiss)

*Guidelines for written 'informed consent' attached where applicable

cc: Supervisor : Dr R Weiner

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10005, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix-F

INSTITUTIONAL REVIEW BOARD
IFAKARA RESEARCH AND DEVELOPMENT CENTRE
P.O.BOX 53
IFAKARA, TANZANIA
irb@ihrdc.or.tz
Tel: +255 (0) 23 2625164 or +255 (0) 22 2774714
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National Institute of Medical Research
P. O. Box 9653
Dar es Salaam
Email; headquarters@nimr.or.tz

18th October 2007

Justice Ajaari
Ifakara Health Research
P. O. Box 78373
Dar Es Salaam

IHRDC/IRB/No. A 021

INSTITUTIONAL CLEARANCE CERTIFICATE FOR CONDUCTING HEALTH RESEARCH

On 10th October 2007, the Ifakara Health Research and Development Center Institutional Review Board (IHRDC IRB) reviewed the study entitled: **"Does place of delivery affect neonatal mortality in Rufiji in rural Tanzania?"** Version date: **21st September 2007**, submitted by the Supervisor, Dr. Honorati Masanja

The following documents were reviewed:

1. Protocol - version date 21st October 2007
2. CVs

The study has been approved for implementation after IRB consensus.

This certificate thus indicates that; the above-mentioned study has been granted an Institutional ethics clearance to conduct the above named study in Rufiji Tanzania.
The Principal Investigator of the study must ensure that, the following conditions are fulfilled during or after the implementation of the study:

1. PI should submit a six month progress report and the final report at the end of the project
2. **Any amendment**, which will be done after the approval of the protocol, must be communicated as soon as possible to the IRB for another approval.
3. The IHRDC IRB must receive any ethical approval by other review Boards
4. All research must stop after the project expiration date, unless there is prior information and justification to the IRB.
5. There should be plans to give feedback to the community on the findings
6. Any publication needs to pass through the IRB.

The IRB reserves the right to undertake field Inspections to check on the protocol compliance

JOYCE K. IKINGURA
Signature
Chairperson

Sally Mtenga
Signature
Secretary